Supplemental Water Supplies For North Santa Clara Valley & Related Service in San Benito & Santa Cruz Counties and Material Supporting the Conclusions & Recommendations of the Board of Review

FROM: Tri-County Water Authority and the Santa Clara County
Flood Control and Water Conservation District

TO: All Interested Parties

Enclosed are copies of the Report on Supplemental Water Supplies for Santa Clara Valley and Related Service in San Benito and Santa Cruz Counties prepared by the Review Board consisting of Samuel B. Morris, Sidney T. Harding and John Longwell, now deceased. This Board was jointly engaged by the Tri-County Water Authority and by the Santa Clara County Board of Supervisors acting as ex-officio directors of the Santa Clara County Flood Control and Water Conservation District.

The report presents the Review Board's analysis of existing reports, and reports in progress, together with the conclusions and recommendations they have drawn therefrom for the purpose of determining the most feasible plan for importing water into Santa Clara County.

It is anticipated that this report will be one of the fundamental guides in resolving the water problems of Santa Clara County as well as the neighboring counties to the north and to the south.

REPORT
ON
SUPPLEMENTAL WATER SUPPLIES
FOR
NORTH SANTA CLARA VALLEY
And Related Service in
SAN BENITO AND SANTA CRUZ COUNTIES

PREPARED FOR THE

SANTA CLARA-ALAMEDA-SAN BENITO
WATER AUTHORITY

and the

SANTA CLARA COUNTY FLOOD CONTROL AND
WATER CONSERVATION DISTRICT

by the

BOARD OF REVIEW

Samuel B. Morris
S. T. Harding

Consulting Engineers

December, 1960

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San Jose, California

Santa Clara County Flood Control
  and Water Conservation District
112 Hamline Street
San Jose 10, California

Gentlemen:

In accordance with the Agreement for cooperative study between the Santa Clara-Alameda-San Benito Water Authority and the Santa Clara County Flood Control and Water Conservation District dated September 14, 1959, the Review Board is hereby transmitting its final report.

This report includes our conclusions and recommendations followed by the more complete supporting materials on which our conclusions are based.

In the report we have expressed our appreciation of the assistance we have received from Messrs. Sullivan and Currlin of your organization and others. The Review Board has received the full cooperation of all of those with whom it has worked. For all of this assistance we are deeply grateful.

Sincerely,

REVIEW BOARD

Samuel B. Morris
Samuel B. Morris

S. T. Harding
S. T. Harding

TABLE OF CONTENTS

Page

INTRODUCTION 1

SUMMARY OF RESULTS 5

RECOMMENDATIONS 19

SUPPORTING MATERIAL

ABBREVIATIONS 1

AREA OF NORTH SANTA CLARA VALLEY 2

AREAS WHICH WILL USE WATER 3

POPULATION 7

RATES OF URBAN USE 12

LOCAL WATER SUPPLY 13

SUPPLY AND USE SINCE 1948 17

PRESENT SOURCES OF SUPPLY 18

- Stream Inflow and Outflow 18
- Stream Outflow 20
- Disposal of Rainfall on the Valley Area 22
- Recharge from Semi-Perched Water Table 23
- Subsidence 27
- Ground Water Movement from Adjacent Hills 29
- Ground Water Inflow from beneath San Francisco Bay 30
- Past Imported Water Supplies 31
- Estimated Total Water Supply 32
- Cloud Seeding 35
- Reuse of Sewage 37
- Ground Water Storage in North Santa Clara Valley 40

QUALITY OF PRESENT AND PROPOSED WATER SUPPLIES 45

USES OF WATER 46

- Water Requirements for Irrigation 46

TABLE OF CONTENTS
(Continued)

Page

USES OF WATER - CONT'D

Water Requirements for Municipal & Industrial Use 47
Total Ground Water Draft 49
Subsurface Outflow to South Santa Clara Valley 49
Total Use of Water 50

CHANGE IN GROUND WATER STORAGE 52

BALANCE OF GROUND WATER SUPPLY AND DRAFT 53

BALANCE BETWEEN SUPPLY AND DEMAND IN FOREBAY AND PRESSURE AREAS 57

Estimates for 1952 to 1959 58
Estimates for 1960 Conditions 61

FUTURE WATER DEMANDS 65

ABILITY TO SUPPLY DEMAND OF NORTH SANTA CLARA VALLEY FROM ITS GROUND WATER 70

SUMMARY OF ESTIMATES OF DRAFT, SUPPLY AND OVERDRAFT OF GROUND WATER OF NORTH SANTA CLARA VALLEY 73

Conclusions of the Review Board 75

ADDITIONAL STORAGE OF LOCAL RUNOFF 77

UNUSED LOCAL SOURCES 80

Northern Valley Project 81
Other Local Reservoirs 82
Projects on Adjacent Streams 82
Summary of Local and Adjacent Projects 83

CROSS VALLEY PROJECT 84

MORGAN HILL PROJECT 87

BERRYESSA PERCOLATION PROJECT 88

GENERAL CONDITIONS RELATING TO THE USE OF IMPORTED WATER 90

TABLE OF CONTENTS
(Continued)

Page

PLANS FOR THE STATE'S SOUTH BAY AQUEDUCT 98

CONDUIT AIRPOINT TO COYOTE CREEK 104

CROSS VALLEY CONDUIT FROM COYOTE CREEK 109

PIPE LINE FROM AIRPOINT RESERVOIR TO THE CITIES IN THE NORTHWESTERN PART OF SANTA CLARA COUNTY 111

SUMMARY 114

PACHECO PASS TUNNEL ROUTE 115

PACHECO PASS PROJECT PROPOSED BY THE STATE 117

- Project from Delta-Mendota Canal 119
- Allocation of Costs 124
- Total Estimated Costs of Delivered Water 130
- Pacheco Pass Project Diverting from San Luis Reservoir 134

WATER SUPPLY OBTAINABLE FROM SAN FRANCISCO FOR USE IN NORTH SANTA CLARA VALLEY 139

INVESTIGATIONS OF SAN FELIPE DIVISION OF CENTRAL VALLEY PROJECT OF U.S. BUREAU OF RECLAMATION 151

COMPARISON OF ALTERNATE SOURCES OF IMPORTED WATER SUPPLY 154

WATER DEMANDS IN SAN BENITO COUNTY 159

ESTIMATED COSTS FOR IMPORTED WATER FOR USE IN SAN BENITO COUNTY 163

WATER DEMANDS FOR PAJARO VALLEY IN SANTA CRUZ & MONTEREY COUNTIES 168

GENERAL CONSIDERATIONS 171

REFERENCE MATERIALS USED BY THE REVIEW BOARD 179

MAP OF NORTH SANTA CLARA VALLEY 185

INTRODUCTION

This report has been prepared in accordance with the Agreement for Cooperative Study of the Santa-Clara-Alameda-San Benito Water Authority and the Santa Clara County Flood Control and Water Conservation District dated September 14, 1959. This agreement provided for the appointment of a Review Board to:

"(1) Review all available reports, data, and information and on the basis thereof to recommend the most feasible method of bringing supplemental water into water deficient areas of Santa Clara County; and

(2) To list, if necessary, such further subjects and areas of study as in this Review Board's opinion are required in order to reach the above recommendation; and

(3) After studies outlined in 2 above are completed and reviewed (if such studies were recommended) to make final recommendations."

This agreement also provided that each of the cooperating agencies should appoint one member of the Review Board with these two members selecting the third member. The Authority appointed Mr. Samuel B. Morris and the Flood Control District, Mr. John S. Longwell. These two members selected Mr. S. T. Harding to complete the Review Board. This Board undertook its assignment as a Board of three members until the death of Mr. Longwell on March 25, 1960. By agreement with the cooperating agencies Messrs. Morris and Harding continued as a Board of two to the completion of this report.

A review of the existing reports and those under preparation by local, state and federal agencies resulted in the conclusion by the Board that no extensive further investigations were needed to enable it to complete the third item in its assignment. Several reports by others have been completed and made available to the Board during the progress of its work. The investigations being made by the U. S. Bureau of Reclamation are still in progress; their results to date have been made available to the Board. The Board has requested information in addition to that contained in completed reports of the cooperating agencies. This has been supplied by these agencies without the formality of the requests provided for in Item (2) of its assignment. While not a direct party to the agreement for the cooperative study, the Santa Clara Valley Water Conservation District has made available all of its records and has met all requests of the Board. The records of this operating agency began with its organization in 1929. The obligation of the Board to all of these agencies and to many individuals is gratefully acknowledged.

The assignment to the Board is directed mainly toward recommendations regarding the source or sources of supplemental water supply which should be secured for Santa Clara County. As some of the sources of imported water supply considered include participation with areas in other counties, the Board has considered the probable extent of use by such other areas insofar as such use affects the costs and other factors involved in such joint projects. The primary consideration of the Board, however, has been the sources of water supply for North Santa Clara Valley. The South Santa Clara Valley has a more adequate local supply in relation to its present and prospective uses of water and has not required the detailed consideration that has been given to the North Valley. Consideration has also been given to the conditions and water needs of areas in San Benito and Santa Cruz Counties which may be prospective users of imported waters.

In discussions with the cooperating agencies at the start of its work, the Board was advised that its assignment did not include consideration of and recommendations regarding which agency should construct and operate the local works required for any imported water supply or regarding the particular form of financing which should be used to meet the costs for such works. The Board has observed these limitations on its report. In comparisons of the estimated costs of alternate works it has been necessary to use a uniform interest rate and maturities on bonds. The proposed terms for state financing of four per cent interest and 50 year maturities has been used.

The water supply and its use in this area have been extensively investigated for the past 40 years. Those responsible for securing additional water for the increasing needs are fully acquainted with this background and the general conditions are well known to all who are interested in this area. The Board has taken advantage of this general knowledge and has not included the extent of local description in its report that would be needed in areas where the general conditions were less well known.

The Board's report is based on its conclusion that the Santa Clara Valley is a highly developed and prosperous area which can afford to secure the additional water supplies which it needs, now and in the future, at the cost which may be required to secure them. This conclusion removes the need for the consideration, usual in many areas, of the ability to pay for water in relation to its costs. Preliminary investigation of the use of water and the expected costs for imported supplies supports this conclusion. While the use of water in the Santa Clara Valley in the past has been mainly for irrigation, the rapid rate of urbanization has made the water supply problem of this area increasingly one of use for municipal and industrial purposes.

The conclusions of the Review Board have been prepared in two parts. This introduction and the summary and recommendations which follow have been prepared separately to supply a brief statement of the conclusions of the Board. The studies on which these conclusions rest have also been assembled in a separate report. This supporting material has been prepared for use by those who may desire to examine the studies of the Board on which its conclusions are based.

SUMMARY OF CONCLUSIONS

1 - The differences in the ground water conditions in the unconfined or Forebay Area and the confined or Pressure Area of North Santa Clara Valley make it essential that the differences in their physical conditions should be recognized. Recharge of the ground water in the Forebay is direct. Recharge in the Pressure Area is controlled by the rate at which ground water can be transmitted to its more distant positions.

2 - For the 1960 draft and the mean annual local water supply regulated by the existing storage and percolation areas, the over-all water supply in the Forebay is now about equal to the draft. While this is true over-all there are some parts of the Forebay in which the drafts exceed the supply.

3 - In the Pressure Area there is a present estimated use of from 50, 000 to 60, 000 acre-feet per year in excess of the mean annual permanent supplies available from local sources. This overdraft is now being met from temporary sources of local supply such as water made available by the compaction resulting from land subsidence, ground water movement from beneath San Francisco Bay, greater percolation from rainfall under past conditions than will occur under urbanization, and by imported water purchased from San Francisco.

4 - The cities in the northern part of North Santa Clara Valley have a present total use of about 45, 000 acre-feet per year. Of this nearly 15, 000 acre-feet is now purchased from San Francisco and 30, 000

acre-feet is pumped from the underlying ground water. The most direct and quickest relief for the overdraft on the ground water in the areas of these cities can be secured by the replacement of their present ground water draft by some source of imported surface service.

5 - If the present municipal ground water draft in the northern part of North Santa Clara Valley is replaced with imported surface service, the expansion of these cities into areas now irrigated will further reduce the ground water draft and result in recovery of ground water pressures which will tend to lessen or reverse the present landward ground water slope from the Bay and also check land subsidence.

6 - Replacement of the present ground water depletion in the Forebay by increased percolation there will steepen the ground water slope into the Pressure Area. The present annual ground water movement from the Forebay to the Pressure Area is estimated to be of the order of 70,000 acre-feet per year. By raising the ground water in the Forebay, the present draft in the adjacent portions of the Pressure Area can be met. While eventually some surface service may be required as use is increased, it appears that the drafts for San Jose, Santa Clara and the municipalities in the southwest portion of the Pressure Area can be met by recharge in the Forebay.

7 - While historically the main draft on the ground water has been for irrigation, the North Santa Clara Valley is rapidly becoming urbanized. Water to maintain irrigation until it may be replaced is essential but

future projects for additional water supply should be planned and financed mainly to meet the demands for municipal and industrial use. Construction of separate surface service for irrigation does not appear to be justified for the diminishing use for agriculture. Irrigation use will need to continue to be supplied by ground water draft until it is replaced by other uses.

8 - A local source of water supply which may become available is the reclamation of sewage. The discharge of the San Jose sewer system has been about 30,000 acre-feet per year. Plans are being made for the construction of treatment works which are expected to provide an output suitable for use for percolation to the ground water. The character of such sewage and its treatment and costs are not as yet fully determined. Should such a source of supply become available for use, it can be pumped for percolation along Penitencia Creek or into a conduit from Airpoint to other Forebay areas. Such a source would meet a part of the total demand but would not remove the need for other imported water.

9 - There are only limited amounts of local stream flow not now used which can be conserved at feasible costs. Present storage on Coyote and Los Gatos Creeks provide nearly complete regulation. Projects to import water from adjacent drainage areas are also limited. The Review Board has concluded that neither an increase in local precipitation from cloud seeding nor reclamation of sea water can be relied upon as a solution to the present water supply problems of this area. Water to meet present and future needs will have to be secured from more distant sources.

10 - It is concluded that North Santa Clara Valley has a present need for an imported supply of 50,000 acre-feet per year in addition to the present purchases of imported water from San Francisco. It is not economical to construct a project with a capacity only sufficient for present needs; additional capacity to meet the increasing needs of a reasonable future period should be included. The present proposed capacity of the South Bay Aqueduct for delivery to North Santa Clara Valley is 88,000 acre-feet per year. This is a reasonable amount of water to be sought in plans for a project to be constructed at this time.

11 - As previously stated, to meet present overdrafts any imported water supply will have to be used for surface service in the northern portion of the Pressure Area. No amount of recharge of the Forebay, even to the extent of restoring the original ground water elevations there, can be expected to result in sufficient transmission of ground water into the Pressure Area to supply its more distant portions under their present and increasing drafts.

12 - The present storage developments on local streams make available water which fully utilizes the capacity of present spreading grounds now served from Coyote Creek. If additional water is to be percolated in the Forebay, additional percolation areas will be required. This has been recognized by the Santa Clara Valley Water Conservation District and such spreading grounds have been planned and are in the process of being acquired. The additional percolation areas are located in the southwestern part of the Forebay, largely along Los Gatos Creek. To

be effective they will have to be supplied with imported water. An essential of any project for imported water is that it can deliver part of its supply where it may be conveyed to the spreading areas planned in the Forebay.

13 - There are three prospective outside agencies which may deliver imported water to North Santa Clara Valley. There are also two alternate routes by which two of these agencies may import water to the Valley. These are: -

1. The State, acting through its Department of Water Resources, using the South Bay Aqueduct, the Pacheco Pass Route or both.
2. The City of San Francisco selling Hetch Hetchy water for municipal use only in the northern portion of the Valley.
3. The Federal Government, acting through the Bureau of Reclamation of the Department of the Interior, delivering Central Valley Project water by a South Bay Aqueduct, a Pacheco Pass Route or both.

14 - The alternate proposals for a South Bay Aqueduct or a Pacheco Pass Route have been compared on the basis of their delivery requirements and costs. Both routes will need to deliver surface service in the northern part of the Pressure Area and water for percolation in the Forebay. A South Bay Aqueduct, if constructed to Airpoint, can deliver surface

service in the northern area but would need to be extended to Coyote Creek to meet delivery into the proposed Cross Valley Project of the Santa Clara Valley Water Conservation District. A Pacheco Pass Route can deliver water at a similar point on Coyote Creek for percolation in the Forebay but would need extensions beyond Los Gatos Creek to Palo Alto on the west side and some form of conveyance to Milpitas on the east side if the needs of the northern part of the Pressure Area are to be met.

15 - All plans for importing water to North Santa Clara Valley will be expensive both in total construction cost and in cost per acre-foot of use. While these costs are within the capacity to pay for municipal use, they may exceed the price which even the high return crops of this area may care to incur for irrigation except as shared with lower cost local water.

16 - Imported water will have high capital charges whether the project is fully or partially used. This is a necessary condition in all projects making limited use in their earlier years of the additional supply made available. Construction works making an economic provision for future increase in use will have high costs per acre-foot for the smaller quantities delivered in early years. To illustrate these conditions cost estimates have been assembled for use of new sources of imported water of 30,000, 60,000, and 88,000 acre-feet per year. Any project that may be built should have a minimum initial use of over 30,000 acre-feet per year. Use should be 60,000 acre-feet per year in the early years in

order to avoid further overdraft and restore past depletion. A use of 88,000 acre-feet per year should be reached in 15 to 20 years, and may be put to use earlier to restore the presently overdrawn ground water.

17 - The estimated costs for a State Project for water imported by the South Bay Aqueduct and the Pacheco Pass Route for different common points of delivery are compared in the following tables. These estimated costs are based on financing with 50-year bonds at four per cent interest and include all estimated operation and maintenance expenses. The estimated costs for untreated water are shown in Table 1 and for treated water in Table 2. Treatment is only included for water to be delivered for surface service for municipal and industrial uses. Water to be percolated to the ground water is assumed to be usable without treatment if applied on the surface as planned.

TABLE 1

ESTIMATED COSTS FOR DELIVERY OF UNTREATED WATER

		Per Acre-Foot of Annual Delivery For Amounts of Annual Delivery in Acre-Feet of		
	PROJECT	30,000	60,000	88,000
	FROM SOUTH BAY AQUEDUCT AND DELIVERY AROUND THE VALLEY:			
1.	For delivery at Airpoint	$ 48.10	$ 30.80	$ 24.80
2.	For conveyance Airpoint to Coyote Creek	15.00	7.50	5.00
3.	Total for delivery to Coyote Creek	63.10	38.30	29.80
4.	For conveyance Coyote Cr. to Los Gatos Cr.	18.85	10.70	8.15
5.	Total for delivery to Los Gatos Cr.	81.95	49.00	37.95
6.	For conveyance Los Gatos Cr. to Palo Alto	14.20	7.10	5.00
7.	Total for delivery to Palo Alto	96.15	56.10	42.95
	FROM SOUTH BAY AQUEDUCT AND DELIVERY ACROSS THE NORTHERN PART OF THE VALLEY:			
8.	For delivery at Airpoint	48.10	30.80	24.84
9.	For conveyance across the Valley	19.00	9.50	6.50
10.	Total for delivery to Palo Alto	67.10	40.30	31.30
	FROM PACHECO PASS ROUTE:			
11.	For delivery by State to Coyote Creek from San Luis Reservoir	67.60	42.40	34.30
12.	For conveyance Coyote Cr. to Los Gatos Cr.	18.85	10.70	8.15
13.	Total for delivery to Los Gatos Cr.	86.45	53.10	42.45
13.	For conveyance Los Gatos Cr. to Palo Alto	14.20	7.10	5.00
15.	Total for delivery to Palo Alto	100.65	60.20	47.45

NOTE: Delivery to Palo Alto is used to represent the delivery to the cities in the northern part of North Santa Clara Valley.

TABLE 2

ESTIMATED COSTS PER ACRE-FOOT FOR DELIVERY OF TREATED WATER TO NORTHERN PART OF PRESSURE AREA

PROJECT	For Amounts of Annual Delivery in Acre-Feet of 30,000	60,000	88,000
Cost of treatment for municipal surface delivery	$ 11.40	$ 8.70	$ 7.85
Total costs by South Bay Aqueduct from Airpoint			
1. Conduit across Northern part of Valley	78.50	49.00	39.15
2. Conduit around the Valley	107.55	64.80	50.80
By Pacheco Pass Route			
3. By delivery to Coyote Creek and conduit around the west side of the Valley	112.05	68.90	55.30

18 - The Review Board finds that the South Bay Aqueduct will meet the requirements for importing water more readily and at less cost than the Pacheco Pass Route. The present estimates of cost for delivery at a common point on Coyote Creek are somewhat in favor of the South Bay Aqueduct although the differences are within the probable error of the estimates. The South Bay Aqueduct extended to the south from Airpoint can supply percolation areas along its route on the eastside as on Penitencia Creek. There will be a greater use by Alameda County sharing in common portions of the works on the upper parts of the South Bay Aqueduct than by San Benito County on the Pacheco Pass

Route. The South Bay Aqueduct is further along in its authorization and construction than the Pacheco Pass Route and can probably provide water at an earlier date. Delivery for surface service in the northern Pressure Area can be made at materially lower cost from the South Bay Aqueduct.

19 - Water is being sold in the northern part of the Pressure Area by San Francisco with deliveries being made from its existing Hetch Hetchy pipe lines. San Francisco has stated its willingness and ability to continue this service and to meet the increasing needs of its customers. Under the terms of the Raker Act governing use of Hetch Hetchy water, it can only be sold outside of San Francisco to public agencies for municipal purposes. This limits its use in northern Santa Clara Valley to municipalities or other forms of public agencies. San Francisco has defined the area in Santa Clara County which it is prepared to serve as that portion of the Santa Clara Valley lying northerly of the City of Santa Clara. As service from San Francisco will not be usable to recharge the Forebay, purchase of its municipal supply by the cities in the northern portion of the Pressure Area can be only a partial solution to the water needs of the North Santa Clara Valley.

20 - At present water is being sold by San Francisco to purchasers in Santa Clara County for resale at only slightly higher rates for equivalent service than are charged to individual customers in San Francisco. Service in San Francisco includes the costs of local distribution; such costs in Santa Clara County are met by the local purchasers. These present rates vary with the extent of use. For a sale of one million gallons per day continuous use the cost would be $74.38 per acre-foot. For a use

of 20 M.G.D. the cost would be approximately $70.00 per acre-foot. For smaller amounts or less continuous service the price is higher. These prices apply to treated water from an already constructed system. Outside customers carry no tax liability for repayment of construction costs. San Francisco desires 20-year contracts for future service in order that it may have security for the costs of the enlargement of its facilities which are now needed to increase the capacity of the Hetch Hetchy supply. The San Francisco's rates are not subject to review by the State Public Utility Commission.

21 - While sales are being made by San Francisco in Santa Clara County which have been of major assistance to the purchasing cities in meeting their water demands, there has been only limited progress made in entering into long time commitments for continued service. These cities are independent entities and may secure their individual supplies separately. Any program for a state project or for expansion of the Hetch Hetchy system by San Francisco is dependent on decisions by these cities as to their source of imported water. Such decisions by these cities have been deferred pending progress on the State's project. It is now essential that the source from which these cities will secure their additional imported supply be decided. Such decisions are required before definite plans can be made to provide such water from whatever source may be selected.

22 - The U. S. Bureau of Reclamation is now making an investigation of water service to the South Bay Area including San Benito and Santa Cruz Counties in what it terms the San Felipe Division of its Central

Valley Project. This work is being done in cooperation with the Alameda-Santa Clara-San Benito Water Authority. Such a project would be subject to the terms of the Reclamation Act which includes interest free repayment of construction costs allocated to irrigation. Costs allocated to municipal use are charged interest. Municipal use may also be required to assist in meeting irrigation costs. As the use in North Santa Clara Valley will have become mainly municipal during the repayment period for a federal project, the interest saving for federal construction will be in the difference, if any, between the interest rate charged by the Federal Government for municipal use and the interest rate at which the State or a local agency can sell its bonds. By making the San Felipe Division a part of the Central Valley Project, reduction in irrigation costs might be secured resulting from participation in power earnings and from a lower price for power for project pumping. The plan of service which may be proposed and the estimated costs resulting from the investigations now in progress will not be known until the completion of the Bureau's report which is now scheduled for July 1962.

23 - There is general agreement that the North Santa Clara Valley will become urbanized and that its future water requirements will be represented by the municipal and industrial use on its 165,000 acres of valley lands plus the areas of the adjacent hills and tidal lands which may be developed. Different estimates of the time when such complete development may be reached and its ultimate water requirements vary. The Review Board agrees with the general conclusions regarding the character of the ultimate development. It has concluded that any present forecast of when

this development may be reached is necessarily speculative and uncertain. There will be sufficient time in which to plan and construct additions to the present project recommended by the Review Board before there is need for water in addition to that which such an initial project will provide. The Review Board has not attempted to schedule the time at which an imported supply, in addition to the 88,000 acre-feet per year now recommended, should be constructed.

24 - The Review Board has concluded that an imported supply of about 100,000 acre-feet per year, in addition to the 88,000 acre-feet proposed for present construction, will ultimately be needed for North Santa Clara Valley. It may be found that it will be economical to construct such additional capacity in either one or two units; this can be decided before the full use of the capacity recommended for present construction is reached.

25 - The Review Board has considered the conditions in the other portions of Santa Clara County and in San Benito and Santa Cruz Counties and has concluded that:

South Santa Clara Valley

The present local sources of water supply available to South Santa Clara Valley appear to be adequate to meet its present and foreseeable needs. Should future development require an imported supply there will be time to secure it before the need becomes critical. This area is within economical distance of conveyance from either a South Bay Aqueduct supply delivered at Coyote Creek or the outlet of a Pacheco Pass Tunnel. No participation in a present source of imported water is recommended.

San Benito County.

The present need for imported water in San Benito County is insufficient by itself to support the costs of a delivery through a Pacheco Pass Tunnel. Some additional development of local sources is in progress. No present project for delivering imported water to this area has been proposed that appears to have costs within the value of the present uses of water for agriculture. The construction of a South Bay Aqueduct to deliver imported water at Coyote Creek would make available an opportunity to extend its service to San Benito County if this should become desirable. For the present it is recommended that San Benito County proceed with its local storage until the report of the Bureau of Reclamation on its San Felipe Division of the Central Valley Project becomes available in 1962 and that it then consider its needs in connection with the opportunities presented in the Bureau's report.

Santa Cruz and Monterey Counties

For Santa Cruz County, the recommendation of the Review Board is the same as that for San Benito County. It is recommended that no present action relating to securing imported water be made until the report of the Bureau of Reclamation is available. The same conclusion applies to the Pajaro Valley area in northern Monterey County.

RECOMMENDATIONS

Based on the preceding conclusions the Review Board makes the following recommendations: -

1. Water from a South Bay Aqueduct is better adapted to the conditions to be met in North Santa Clara Valley than a Pacheco Pass Route, can be made available sooner, and also has a lower estimated cost for all of the service required. An imported supply from some other source will be required even if Hetch Hetchy water is used to the full extent to which it is available. On the basis of these conclusions, the Review Board recommends that construction of a South Bay Aqueduct be supported actively by North Santa Clara Valley and its completion to Airpoint Reservoir be accomplished.

2. The Review Board recommends that the local decisions that are needed be made promptly regarding service of South Bay Aqueduct water within North Santa Clara Valley so that negotiations regarding the selected sources of supply may be undertaken. The decisions that are needed include: -

A - At what point should construction by an outside agency end and local distribution works begin? At present the State's delivery is planned to be at Airpoint. This is a suitable terminus.

B - From which source, Hetch Hetchy or a South Bay Aqueduct, will the cities in the northern part of the Pressure Area secure their future imported supply? If a South Bay Aqueduct is to be used, what agency will construct and operate the conduit and treatment plant from Airpoint? If Hetch Hetchy water is to be used negotiations of agreements with San Francisco for continued service should be undertaken and completed. Whether the cities in the northern part of the Pressure Area secure their additional supply from San Francisco or from a South Bay Aqueduct will affect the demands and the cost allocation for the South Bay Aqueduct. If North Santa Clara Valley secures all of its imported water from a South Bay Aqueduct, the larger supply from the Aqueduct for North Santa Clara Valley will reduce its average cost per acre foot. If these cities secure all of their imported water supply from San Francisco, the use of a South Bay Aqueduct will be for recharge of the ground water in the Forebay. For such use the requirements for surface storage on the Aqueduct, such as at Arroyo del Valle or Airpoint, are reduced as ground water in the Forebay provides its own storage.

C - What agency will construct and operate the conduits from Airpoint to Coyote Creek for percolation of imported water in the spreading areas of the Santa Clara Valley Water Conservation District? Plans for financing and constructing a conduit from Airpoint to Coyote Creek should be made so that it will be available for operation at the time imported water may be delivered at Airpoint.

D - The present plans of the Santa Clara Valley Water Conservation District for the West Side Project are adapted to use for distribution of imported water delivered at Coyote Creek for percolation in the western portion of the Forebay. This project, including the acquirement of the necessary spreading areas, should be ready for use when imported water may be available.

3. Decisions regarding these items are essential before the North Santa Clara Valley can complete negotiations regarding its participation in a South Bay Aqueduct. If such an Aqueduct is to supply the municipal uses of the northern cities there will be less difference in the charges for water between a project constructed by the State and by the Bureau of Reclamation. Negotiations with the State relating to participation in its South Bay Aqueduct can be undertaken now if the total use is to be supplied from this source.

4. If the northern cities secure their imported supply from San Francisco and the use of a South Bay Aqueduct is limited to the recharge of the Forebay, the relative opportunities and costs of State or Bureau of Reclamation construction of the Aqueduct will not be known until the Bureau of Reclamation report may be completed. This is now scheduled for July 1962.

5. The present water supply conditions in the Forebay are not as critical as those in the northern part of the Pressure Area. If the total demands of the cities in the northern part of the Pressure Area are to be supplied by San Francisco, the Forebay can continue its use of its present sources until the report of the Bureau of Reclamation becomes available and the conditions of service of the State and the Bureau can be compared.

6. As stated in the Introduction, the directions to the Review Board excluded its consideration of which local agency should contract for repayment and should operate the local distribution system to receive the

imported water so vitally necessary. The Board has observed this direction and has made no recommendations regarding which local agency should represent the North Santa Clara Valley in negotiations and in contracts relating to securing imported water. The Board has attempted to present the relative costs and conditions applicable to the different potential sources. On the basis of this information local interests can make their decisions regarding how this area may desire to proceed to secure an imported water supply. The Board does urge that the necessary local decisions listed above be made as promptly as practicable so that the North Santa Clara Valley may proceed responsibly on the activities needed to meet its water needs.

MATERIAL
SUPPORTING THE
CONCLUSIONS AND RECOMMENDATIONS
# of the
BOARD OF REVIEW
IN ITS REPORT OF
DECEMBER 1960

on

SUPPLEMENTAL WATER SUPPLIES
for
NORTH SANTA CLARA VALLEY
And Related Service in
SAN BENITO AND SANTA CRUZ COUNTIES

Samuel B. Morris S. T. Harding

Consulting Engineers

ABBREVIATIONS

To avoid repetition of the full names of public agencies, the following designations have been used:

1 - The Santa Clara-Alameda-San Benito Water Authority has been called the Authority.

2 - The Santa Clara County Flood Control and Water Conservation District has been called the Flood Control District.

3 - The Santa Clara Valley Water Conservation District has been called the Conservation District.

4 - State for the State Department of Water Resources and its predecessor agencies.

5 - Bureau for the Bureau of Reclamation of the U. S. Department of the Interior.

6 - San Francisco for the Water Department and Hetch Hetchy System of the City and County of San Francisco.

AREA OF NORTH SANTA CLARA VALLEY

Development of the North Santa Clara Valley to date has been almost entirely on the valley floor. While it is expected that residential areas will expand into the adjacent hilly areas, the main volume of future use will probably continue to be on the valley lands. These have a fairly definite limit to their area; the total use on these valley lands will depend on their population density under full development.

On the bay shore side, the definition of valley lands extends to below the high tide line. There has been general agreement on this dividing line in the different past reports. It is anticipated that eventually some tidal areas at the south end of the Bay will be reclaimed and require water for their use. While this potential use is recognized, it is concluded that it will not occur until the more readily available valley lands have been fully urbanized. Prospective costs of reclamation of tidal areas makes their use for agriculture improbable. Their development for other uses will probably be deferred until subsidence has been overcome. It is the opinion of the Review Board that a water supply for tidal areas is not a factor in present programs for North Santa Clara Valley. The development of such areas will affect the ultimate water requirement but not the use of water in the foreseeable future. Estimated requirements for these tidal areas have not been included in the programs proposed in this report.

AREAS WHICH WILL USE WATER

The present and future areas which will use water in North Santa Clara Valley have been surveyed and estimated in different reports. A field survey was made in 1948-49 in the preparation of the State's Bulletin 7 (see pp. 53-54 and Plate 16).

The total area classified in the State's Bulletin 7 consisted of 165,100 acres of land in use in 1948-49 with 40,400 acres of hill lands and 4,000 acres of marsh lands which it was estimated would be used under ultimate development. The present and ultimate areas assigned to different types of use are given in Tables 25, 26, 27, and 28 of Bulletin 7. These uses are divided in some results between the Forebay and Pressure Area.

Plate 16 in Bulletin 7 shows the land use in 1955 divided into irrigated and irrigable lands and urban development in 1949 and since 1949. The boundary of the investigated area is shown enclosing the irrigated area. Apparently the lands classified do not include the irrigable hill lands nor the marsh lands.

In Table 25 of Bulletin 7 the land use in 1948-49 was classified as follows: -

		Acres
Irrigated land		100,400
Nonirrigated land		
Dry-farmed and native grasses	23,300	
Dry-farmed orchard	1,000	
Fallow lands	600	
Brush and trees	4,200	29,100
Urban Areas		23,900
Farmsteads and Miscellaneous		
Farmsteads	1,900	
Roads and Railroads	8,000	
Water Surface	1,800	11,700
TOTAL		165,100

In Table 28 of Bulletin 7 the estimated probable ultimate pattern of land use is as follows: -

	Acres
Irrigated lands	7,300
Nonirrigated lands	0
Urban areas	151,000
Farmsteads	200
Miscellaneous	6,600
Subtotal	165,100
Hills	40,400
Marsh lands	4,000
TOTAL	209,500

Perrott and Dunn in their report of March 1957 classified the lands in Northern Santa Clara Valley as follows: -

	Acres
Valley lands	141,020
Rolling Foothills	47,800
Salt Ponds and Marshes	13,760
Bay Water Surface	2,440
Subtotal	205,020
Mountainous Terrain	113,200
TOTAL	318,220

All of this area is estimated to have water requirements under ultimate development based on population densities from 3 to 15 persons per acre.

Plate A-1 of this report shows the boundary of the area used by the State in Bulletin 7 and the boundary of the larger area used by Perrott and Dunn. A boundary for the valley land used by Perrott and Dunn is not shown so that a comparison of the 141,020 used in their report with the 165,100 acres used in Bulletin 7 cannot be made from these results.

In Appendix A of Creegan and D'Angelo's report on "Northern Santa Clara Valley Water Demand" of August 1960, the service area is shown as approximately 204,000 acres. The derivation or classification of this area is not stated.

In the Division of Water Resources Bulletin 42 entitled "Santa Clara Investigation" published in 1933 the area of the Santa Clara Valley Water Conservation District is stated to be 133,000 acres with 53.4 square miles of additional area between the mountain and foothill area giving a total valley area of 167,200 acres.

In Bulletin 2 of the Water Resources Board the areas in the Santa Clara Valley were as follows: -

	Acres
Irrigated	105,000
Dry farmed	31,000
Urban and Suburban areas	22,300
Streets and vacant	10,500
TOTAL	168,800

From these data it is concluded that the areas for which a water supply may be needed in North Santa Clara Valley are as follows: -

	Acres
Present Areas	
Gross Valley Areas	165,100
Future Areas	
Hills	40,400
Marsh lands	4,000
TOTAL	209,500

It is considered that the valley lands include the following lands which will not use water. These results are taken from

Table 25, p. 53 of Bulletin 7 for conditions in 1948-49.

Farmsteads, Roads and Railroads and Water Surfaces	11,700
Brush and Trees	4,200
	15,900
Valley lands requiring water	149,200

The gross areas of valley land derived by the Bureau and the State are shown later herein in Table 4. These total areas agree within one per cent; either result can be used in considering total demands. These results also segregate the total area between the unconfined and confined areas. This segregation shows that the Bureau has included 8,700 acres more area in the confined area than the State with a reverse difference in the unconfined area. This difference does not affect the total use of water but is a factor in meeting the demand by the use of ground water as recharge can be increased directly only in the unconfined area.

POPULATION

Several forecasts of the future population of the North Santa Clara Valley have been made. These have covered to the year 2000 or 2020. In order to compare these estimates for a relatively short period in the future and for the full period of 50 to 60 years to which they have been extended, the results for 1970 and the latest date used in each report are shown.

Some results require interpretation to provide results applicable to the North Santa Clara Valley. This is discussed for each instance where adjustments have been made.

The State has made several forecasts of the population in North Santa Clara Valley. The estimates of future use of water in Bulletin 7 (1955) were based on a classification of the urban areas and rates of use per acre without specific forecasts of population.

In Bulletin 60 on "Salinity Control Barrier Investigations" (1957) population estimates designated as Santa Clara County were made. These results, while designated for the County, appear to be applicable to the portion of the County tributary to San Francisco Bay. This is the same as the North Santa Clara Valley. This estimate was a population of 610,000 in 1970 and 1,150,000 in 2010.

The Greydanus report of April 21, 1958, used the population projections in Bulletin 60 to derive estimated water demands per acre but did not include results for population separately. In the State report by Cline of December 11, 1959, for the South Bay Area in Santa Clara County (Area H-7 in Bulletin 2) the population estimate was 930,000 in 1970 and 2,000,000 in 2010. The estimated total supplemental water requirements in the Greydanus and Cline reports are as follows: -

	Total Supplemental Water Requirement in Acre-Feet		
	Greydanus	Cline	Per Cent Increase Cline Over Greydanus
1970	62,000	111,000	79
2010	88,000	217,000	147

This comparison represents a relatively large increase in the State's estimated supplemental water requirement during the 20 months between the dates of these two reports. The increase in the Cline report results largely from a larger estimate of the population than that used by Greydanus with a corresponding increase in municipal use.

Population estimates have also been made in reports for local agencies. Perrott and Dunn in their report for the Authority of March 1957 estimated an ultimate population of 2,160,000 on 141,020 acres of valley land.

In a letter report to the Flood Control District dated October 14, 1959, the Santa Clara County Planning Departments made the following forecasts: -

	Population in Thousands		
	1970	2010	Increase
County Wide Population	1,032	2,532	1,500
North County Population	947	2,230	1,283
Per Cent of Total in North County	92	88	86

In its "Future Development of the San Francisco Bay Area 1960-2020" the U. S. Department of Commerce made population projections by decades from 1960 to 2020. These were based on different assumptions regarding migration rates, national fertility levels and mortality rates. The results are shown by counties in Appendix B of this report.

For 1970 and 2020 the results for Santa Clara County are as follows:-

Population Projection in Thousands
Santa Clara County

		1970	2020	Increase
Projection Series	1 - II	886	3,401	2,515
	2 - II	743	2,362	1,619
	1 - IV	846	2,479	1,633
	2 - IV	708	1,699	991

The Commerce report (Table 7) was based on an area density method which gave an estimated population in Santa Clara County in 1970 of 820,000 and in 2020 of 2,950,000.

The population estimate for 1970 adopted in the Commerce report is about the mean of the four estimates in its Appendix B. For 2020 the four estimates in Appendix B have a mean population of 2,485,000; the adopted estimate used in Table 7 exceeds three of these estimates and is nearly a half million greater than their mean. While the range of the different results for 1970 is only 178,000 or 23 per cent of their mean, for 2020 the similar range is 1,702,000 or 68 per cent of the mean.

The estimate for Santa Clara County are not applicable directly to the North Santa Clara Valley although it is and will be the most populous part of the county.

Based on the estimates of the Santa Clara County Planning Department about 90 per cent of the results of the U. S. Department of Commerce may be in the North Santa Clara Valley. This would represent a population there in 1970 of about 740,000 and in 2020 of 2,650,000.

The various estimates which have been discussed show a range in the population forecast for 1970 from 610,000 to 947,000 or a difference between the minimum and the maximum of about 50 per cent of the minimum. This is for a 10 year projection.

For the 50 to 60 year projections the estimates vary from 1,150,000 in Bulletin 60 in 1957, 2,160,000 by Perrott and Dunn in 1957, 2,000,000 by the State and 2,230,000 by the Santa Clara County Planning Commission in 1959 and 2,650,000 by the U. S. Department of Commerce in 1960.

The Review Board has not attempted to make a forecast of its own on the future population in North Santa Clara Valley. As developed later in this report, the Board has recommended works which it is expected to meet the water needs of the Valley for the next 15 to 20 years and has suggested that much better plans for the next stage of water supply can be made when the time when it will be needed is approaching. The Board is in agreement with the conclusion reached in all recent reports that the Valley is and will continue to become urbanized and that a large population growth will occur. The Board has not attempted to define the time at which different amounts of such urbanization may be reached or the population that will be in the Valley at remote future dates.

RATES OF URBAN USE

The rates of urban use can be expressed in terms of gallons per capita per day, acre-feet per capita per year and acre-feet per acre where the population density is known or is estimated.

In the report of the State by Cline of December 11, 1959, on "South Bay Area Water Requirements", these estimates are given in Table 7 for each decade from 1960 to 2020. Cline used the estimates of the Santa Clara County Planning Department. He forecasts a continuing future increase in the G. P. D. per capita. This is usual as forecasters anticipate an expanding rate of use of water per capita as more water consuming devices come into use. The population densities are representative of those usual in single family residential areas. Applied to the 165,000 acres of valley land, these rates represent a total population at ultimate development of over 1,500,000. The average rates of use in acre-feet per acre is moderate and similar in amount to that for irrigation. The estimates in Cline's report are as follows: -

	G.P.D. per Capita	Acre-Feet Per Year per Capita	Population Density - Valley & Mesa	Acre-Feet* Per Acre
1960	144	.177	10	1.77
1970	146	.180	10	1.80
1980	149	.184	10	1.84
1990	151	.186	10.1	1.88
2000	153	.188	10.2	1.92
2010	155	.191	10.7	2.05
2020	155	.191	11.2	2.14

* Computed from other columns.

LOCAL WATER SUPPLY

Use of local sources of water supply in the North Santa Clara Valley is primarily from the ground water. Surface stream flow occurs during the winter rainy season with almost no summer flow. Direct diversions from stream flow are very limited. In recent years diversion of stream flow and storage releases has been encouraged by the Conservation District but is, as yet, a minor factor in the over-all practice.

Percolation to the ground water is the principal source of the present use. Such percolation has always occurred from the unregulated stream flow and is now increased by the storage and later release from the surface reservoirs of the Conservation District. Some penetration of rainfall below the reach of plant roots occurs and eventually reaches the water table. Also there is some penetration of rainfall on adjacent hill areas which moves to the valley.

In recent years the ground water lowering has made available two sources of supply. One of these is the so-called water of compaction which is the water released from the confining clays as the ground water pressure is reduced. This is represented by the volume of subsidence which has resulted from the reduced pressure. The other is the ground water inflow from under San Francisco Bay induced by the reduction in ground water pressure to below sea level in the valley areas adjacent to the Bay and the consequent movement of the water inland from under the Bay.

To date only limited amounts of imported water have been used in the North Santa Clara Valley. In recent years some water has been purchased from San Francisco by the cities adjacent to its Hetch Hetchy pipe lines. This has been a small part of the total supply. Similarly there have been no surface exports from the area generally included within the term North Santa Clara Valley. Ground water movement into the southern Santa Clara Valley near Morgan Hill occurs and represents an export from the northern Santa Clara Valley. The amount of such movement is a relatively small item in the total supply.

Any inventory of the local water supply of the North Santa Clara Valley has to take into account the existing conditions. Only a part of the stream flow into the valley contributes to the usable supply as the remainder flows across the area to the Bay. Natural percolation from stream flow has been increased by surface storage and later release within the rates at which the releases will percolate. The amounts of the usable supply has varied as the storage facilities of the Conservation District have been increased. In any inventories attempting to establish the mean annual supply it is necessary to include periods when the conditions have had similar surface storage.

The State in its Bulletin 7 "Santa Clara County Investigation" derived the total local water supply available for the 13 year period from 1935-36 to 1947-48. This period had a mean annual water supply representative of that for the 53 years from 1894-95 to 1946-47.

The gross amounts of the items of the mean annual water supply for this 13 year period, 1935-36 to 1947-48, were estimated in Bulletin 7 to be as follows: -

	Acre-Feet
Precipitation on Forebay Zone	145,000
Surface inflow to Forebay Zone	207,500
Average decrease in ground water storage	4,500
Water of Compaction	4,000
Subsurface inflow other than from adjacent hills	8,000
Import	2,000
Subsurface inflow from adjacent hills	16,200
TOTAL	387,800

For this period the outflow from the surface inflow was an average of 111,300 acre-feet per year leaving a percolation to the ground water from stream flow of 96,200 acre-feet. The decrease in ground water storage represents the mean annual reduction in its volume. This decrease together with the water of compaction and subsurface inflow from other than the adjacent hills (from under San Francisco Bay) are the results of overdraft during this period and are not sources of permanent supply. The import water was the average supply received during these years from San Francisco.

Taking into account these items of overdraft and outflow, the total permanent supply obtainable from local sources during this period becomes 258,000 acre-feet per year. This result represents a period of average water supply with the extent of surface storage then in use. The Conservation District's first storage became operative in 1935. Anderson and Lexington Reservoirs were built after 1948.

Not all of this supply of 258,000 acre-feet reaches the ground water and requires pumping. Of the 145,600 acre-feet of precipitation on the Forebay Area only a portion penetrates below the root zone and reaches the ground water. The results in Tables 29 and 32 of Bulletin 7 (see Table 2) represent an estimate that 113,500 acre-feet of this precipitation would be retained in the surface soil and 32,100 acre-feet would penetrate to the ground water under the average conditions of land use during the 13-year period. These results also do not make separate allowance for runoff from precipitation on the Forebay. Any such surface runoff is included in the record of the outflow. It should be added to the inflow increasing the stream absorption by an amount equal to the reduction in rainfall penetration.

On the basis of these results the mean annual ground water draft which could be maintained for the conditions of the 13-year period would have been 144,500 acre-feet. The stream flow during this period would have been representative of the long time mean. The rainfall penetration would have been applicable only to the average land use conditions during this period.

For the long time mean, a safe mean seasonal ground water yield of the Forebay Area of the North Santa Clara Valley of 134,400 acre-feet was derived in Bulletin 7 (Table 18). This includes allowances for the differences between the water supply for the 13-year and the 53 year periods and also for an item of 3,900 acre-feet year for diversions from Saratoga and Los Gatos Creek which represents a surface supply. This result is applicable to the land use conditions during the 13-year period with the 53 year water supply. In Table 18 of Bulletin 7 this safe ground water yield is designated as for the Forebay. It was derived from the draft on both the Forebay and Pressure Areas and represents the total safe yield for both zones whether this supply is all pumped from the Forebay or whether part is pumped from the Forebay and part is transmitted to the Pressure Area for draft there.

SUPPLY AND USE SINCE 1948

Nearly all items of supply and use require some degree of estimation in their amount. Net draft cannot be directly measured and has to be derived from classifications of the areas served and their estimated rates of use. The elements of water supply can only be estimated from available records and conditions. It is not to be expected that any attempted balance between supply and use will result in complete agreement in its total supply and use.

The items of supply and use were each estimated on the basis of the available records, estimates made by others and the judgment of the Review Board. This was done for each item independently. The results were then combined to enable a comparison to be made of the total supply and use.

PRESENT SOURCES OF SUPPLY

The available records of the various items of water supply are adequate to enable their mean annual amounts to be estimated within an acceptable limit of probable error. This has been done.

Stream Inflow and Outflow

Sufficient records of the surface inflow of the streams tributary to the North Santa Clara Valley are available since 1935 to enable the mean annual total inflow to be derived. Records of the outflow from the Valley in the surface stream channels have been secured.

In Bulletin 7 the State compiled these annual records from 1935-36 to 1947-48 by individual streams in its Table 7.

The mean annual surface inflow and outflow were derived from the available records and correlation with the inflow in Table 9. These results are summarized here in Table 1. The results in Bulletin 7 are the natural runoff adjusted for storage operations. They include estimated items for the runoff of the unmeasured east and west side tributaries amounting to about 25 per cent of the total.

At the request of the Review Board, the Conservation District compiled the records of the measured streams for the years 1948-49 to 1958-59. These records do not include the runoff of San Francisquito, Silver and Dry Creeks or the unmeasured areas which were included in Table 9 of Bulletin 7. These additional items in Table 9 were 27.7 per cent of the runoff of the measured streams reported. The measured items of the Conservation District were increased by this amount to derive a total inflow for these later years comparable with that in Bulletin 7.

Similarly the Conservation District furnished results for the outflow for 1949 to 1959. These results also lacked outflow from the same sources not included in the inflow results. For the mean outflow in Table 9 of Bulletin 7, these omitted items had a mean value of 24.4 per cent of the reported items.

All of these results are summarized in Table 1. The precipitation at San Jose, in percentage of its mean, has been added to indicate the relation of the different periods shown to the mean.

The results for the inflow shown in Table 1 are not directly comparable with the results in Bulletin 7. The results in Bulletin 7 are the recorded runoff adjusted for any carryover in storage. For years prior to 1948 storage affected the monthly inflow but had little effect on annual results. Since Anderson Reservoir began operation in 1951-52 there has been carryover in each of the years shown. There was a carryover at the end of 1959 of 60,800 acre-feet equivalent to an additional mean annual runoff of 7,500 acre-feet per year for the eight years 1952 to 1959. Adding this to the mean inflow for this period, shown in Table 1, gives a total inflow of 211,500 acre-feet for these eight years having an average annual rainfall of 101 per cent of the mean. This result for these later years is in close agreement with the results derived in Bulletin 7 for the years 1936 to 1948. It is concluded that the mean annual surface inflow to North Santa Clara Valley is about 210,000 acre-feet. For use in tables comparing the mean annual supply and use this value has been used.

The results for the surface outflow in Bulletin 7 and for the later years shown in Table 1 enable the effect of the increased storage in Anderson and Lexington Reservoirs, which have been in operation since 1951, to be determined. A similar difference is also shown between the inflow and outflow which is percolated to the ground water. For the periods from 1936 to 1948 some increase in percolation was indicated by the results in Bulletin 7 resulting from the earlier reservoirs. This was materially increased with the additional later storage. The average annual percolation from stream flow with present storage appears to be about 130,000 acre-feet per year, an increase of about 35,000 acre-feet per year over that secured prior to 1951.

Stream Outflow

The records of stream outflow have been discussed in connection with the stream inflow. These results have been assembled for the eleven years, 1948-49 to 1958-59 in Table 1. The eight years 1951-52 to 1958-59 were a period of average precipitation and the results are representative of those applicable with the present works of the Conservation District and the draft during these years. The mean outflow for 1952 to 1959 derived in Table 1 is 73,700 acre-feet per year.

TABLE 1

RECORDS AND ESTIMATES OF SURFACE INFLOW AND OUTFLOW FROM NORTH SANTA CLARA VALLEY

Thousands of Acre-Feet

Period and Year	Inflow	Outflow	Difference	Precipitation in Per Cent of Mean
Results in Bulletin 7				
53 years 1895-1947	203.2	110.0	93.2	100
13 years 1936-1948	207.5	111.3	96.2	101
Later records from Santa Clara Valley Water Conservation District				
1948-49	94.2	19.6	74.6	84
1949-50	52.7	5.8	46.9	61
1950-51	194.8	52.1	142.7	102
1951-52	321.4	157.5	163.9	144
1952-53	135.4	17.2	118.2	70
1953-54	108.5	3.8	104.7	73
1954-55	95.7	4.6	91.1	86
1955-56	308.5	153.8	154.7	132
1956-57	118.6	4.7	113.9	73
1957-58	384.7	230.1	154.6	160
1958-59	159.6	17.5	142.1	71
Mean 1949-59 - 11 years	179.5	60.6	118.9	96
Mean 1950-59 - 10 years	188.0	64.7	123.3	97
Mean 1951-59 - 9 years	203.0	71.5	131.5	101
Mean 1952-59 - 8 years	204.0	73.7	130.3	101

Disposal of Rainfall on the Valley Area

Rainfall on agricultural lands in the valley is largely absorbed by the soil. Some surface runoff occurs from the heavier storms. Urbanization increases the impervious areas and the surface runoff.

Some rainfall penetrates below the plant roots and eventually joins the ground water in the unconfined areas and contributes to the perched water in the confined areas. It is usual to derive the rainfall used by crops from their depth of rooting and the soil moisture holding capacity in relation to the occurrence of precipitation. Such derivations were made in Bulletin 7, Table 29 for the Forebay Area. These results are shown in Table 2.

Table 2 indicates a mean annual rainfall penetration of about 32,000 acre-feet for the period 1936 to 1948. This is the total part of the rainfall not retained by the soil and used consumptively. The results in Table 2 take no account of any surface runoff from the rainfall. Actually the difference between rainfall and consumptive use is the combined surface runoff and deep penetration.

It is not necessary to attempt to separate the rainfall which becomes runoff from the valley land and that which becomes deep percolation. The surface inflow and outflow were derived without including runoff from the valley lands. If an amount, such as 10,000 acre-feet, of mean annual runoff occurs from the valley lands in the Forebay, it joins the surface inflow to the valley and adds to the outflow. If the inflow is increased by any amount of such valley runoff it will make an equal increase in the indicated percolation from the streams to offset the equivalent reduction in deep percolation of rainfall. Table 2 indicates that there was an additional increment to the ground water for this period, not accounted for in Table 1, of about 32,000 acre-feet per year.

This conclusion applies to conditions at the time Bulletin 7 was prepared when the urban areas on the Forebay were 4,200 acres. As this urban area increases, absorption of rainfall and its consumptive use will diminish. Storm sewers will discharge much of the urban run-off onto the Pressure Area. The ground water recharge from rainfall will diminish as urbanization on the Forebay increases. For the period 1950 to 1959 the urban area increased rapidly. This urban increase resulted in some storm water discharge through storm sewers which may not have been included in the stream outflow records. For the mean for the years 1952 to 1959, accretions to the ground water from precipitation have been assumed to have been an average of 27,000 acre-feet per year and the percolation in 1960 with average rainfall, 24,000 acre-feet. While these results are not subject to direct support quantitatively, they appear to be a reasonable approximation for this item.

Recharge From Semi-Perched Water Table

In past reports it has been usual to divide the valley area into a Forebay or unconfined ground water zone and a Pressure Area or confined zone. This division reflects the former artesian conditions. It had also been usual to consider that the surface or perched ground water in

TABLE 2

DERIVIATION OF USE OF PRECIPITATION IN NORTH SANTA CLARA VALLEY IN BULLETIN 7

Irrigated Lands	Total Use	2.5 Ac. Ft. Ac.
Table 29	Use of Precipitation	1.3 " " "
	Ground Water Draft	1.2 " " "

Results for 13 Year Period 1936-48 - Table 32

Forebay Area	Acres	Total Use Acre-feet per Acre	Use of Rainfall Acre-feet per Acre	Total Use of Rainfall
Irrigated lands	53,300	2.5	1.3	69,300
Non-irrigated lands	23,300	1.6	1.6	37,200
Urban areas	4,200	1.7	0.3	1,300
Farmstead	600	2.0	1.0	600
Miscellaneous	5,100	1.0	1.0	5,100
Total Use	86,500			113,500
Total Rainfall				145,600
Indicated rainfall penetration to ground water in Forebay				32,100

the Pressure Zone was separated from and did not contribute to the deeper ground water there. Efforts to balance supply and draft in the Pressure Zone resulted in an excess of draft over the apparent elements of supply. Search was made for additional possible items of supply.

Prior to use of the ground water, the pressures in the artesian area were sufficient to raise the ground water in the wells above the ground surface. The ground water pressures showed a slope toward the Bay. Such a slope indicates ground water movement and movement requires an outlet for the moving water. The original outlet for the ground water in the Pressure Area appears to have been upward seepage through the clay caps. Such seepage appears to have been one of the sources of the water supply for the former moist areas near the Bay. There may also have been ground water movement to areas under the Bay with discharge in other areas.

With pumping and loss of artesian head the hydraulic gradient through the clay caps has been reversed. The former gradient upward has been changed to a downward gradient. If moisture movement upward formerly occurred there should now be a downward movement.

There are now continuing accretions to the perched ground water in the Pressure Area from deep penetration of irrigation use and rainfall and from absorption from stream channels. The perched ground water is generally stable indicating that an outlet exists for its accretions. Under its relatively flat slopes movement of the perched water laterally would be slow and small in amount. Its most probable main outlet is downward movement through the clay caps.

From these considerations it is concluded that the perched ground water in the Pressure Area is a present source of water supply for the deeper strata drawn upon by the wells in this area.

As the perched water has a higher content of total dissolved solids than the deeper water it might be possible to define areas of its percolation by its effect on the draft from the deeper wells. The available analyses do not indicate any definite effects of such mixing.

The fluctuations in the depth to water in the wells in the Pressure Area since 1950 show some areas of gain and other areas of lowering. The areas of gain are generally adjacent to the larger streams crossing the Pressure Area. This may be the result of the larger rate of downward percolation of perched water in such areas. Any breaks or erosion in the clay cap that may exist would more probably occur in the areas where the present streams may have eroded the original clay bed deposits. A greater ground water mound under the stream channels would result in greater percolation there.

The amount of probable percolation from the perched water table can be estimated from the extent of its supply or by derivations of probable rates of percolation through the clay. Such percolation may occur over an area of about 80,000 acres. A rate of general ground water flow of six inches depth per year over this area would result in a downward flow of 40,000 acre-feet per year. The present draft in the Pressure Area is about 140,000 acre-feet. A deep percolation loss of 20 per cent would provide a supply of 28,000 acre-feet per year. The penetration the rainfall and the surface runoff on the Forebay Area has been estimated to be about 20 per cent of the total rainfall. For the generally heavier soils of the Pressure Area the rainfall penetration may be less. It could be 2 to 3 inches depth of water over the area of 80,000 acres or 12,000 to 20,000 acre-feet per year.

These rough generalizations indicate that a ground water supply of perhaps 40,000 acre-feet per year may reach the deeper strata in the Pressure Area by percolation from the perched water table under present conditions.

While no direct numerical verification of the preceding estimate can be made, its general amount appears to be reasonable. It has been used in the trial balance between the items of supply and of draft.

Subsidence

The loss of artesian pressure resulting from the draft on the ground water in the Pressure Area enabled the water of saturation formerly confined in the overlying clays to drain into the underlying strata. The removal of such water of saturation from the clays resulted in the rearrangements of their particles and reduction in their volume. The resulting compaction caused subsidence of the lands overlying these clays. This subsidence occurred so evenly over large areas that it was not recognized until levels were run across the areas of subsidence and well casings began to rise out of the ground.

Sufficient observations of the subsidence which has occurred have been made so that the areas affected and its amount are now generally known. Such observations are being continued.

The Bench Mark at the Santa Clara Court House subsided about five feet from 1912 to 1935, nearly three feet from 1935 to 1954 and a total of over eight feet to date.

It is now the general conclusion that the subsidence which has occurred cannot be restored by any program of replacement of the ground water depletion. Increasing the ground water pressure may resaturate the overlying clays but it will not result in their expansion to their former volume. The loss in land elevation is permanent. The loss of ground water storage capacity in the clays is almost permanent. The subsidence has not caused a material reduction in the more readily usable storage capacity of the coarser materials.

In comparisons of the ground water supply and its use during the years when subsidence has been occurring it is necessary to include an item for the water yielded by such compaction. As this volume is equivalent to the total volume of land settlement it can be estimated from the area and depth of subsidence. Such results related to the rate at which the subsidence has occurred furnish a basis for an estimate of the water supply which has been made available from such compaction.

Using the observations of the U. S. Geological Survey, the State in its Bulletin 7 derived a total volume of subsidence from 1935 to 1948 of 52,000 acre-feet equivalent to an average of about 4,000 acre-feet per year. From 1948 to 1954 there was further subsidence at an accelerated rate but its amount per year was not estimated in Bulletin 7. Records to 1959 have shown continued subsidence.

Cooperative studies of subsidence are in progress by the U.S. Geological Survey, the U. S. Bureau of Reclamation and other agencies. From the results to date the Bureau of Reclamation has estimated that a reduction in volume of the clays of 14,000 acre-feet per year has occurred from 1953 to 1958 and that an equal volume of ground water had been made available to wells in the Pressure Area in these years from this compaction. This estimate has been used by the Review Board for the mean annual compaction for 1952 to 1959 and for 1960.

Ground Water Movement From Adjacent Hills

Some rainfall penetration occurs on the adjacent hills surrounding the North Santa Clara Valley which percolates toward the valley area without appearing as surface flow. The amount of any such supply cannot be measured. While estimates of its probable amount may be made, there is no definite basis on which it can be computed.

In Bulletin 7, the State recognized the probability of such an item of supply and estimated its amount from the excess of the estimated draft over the other elements of supply during a period when the draft and supply were balanced and mean precipitation occurred. The result derived in Bulletin 7 (Table 17, p. 38) was 16,200 acre-feet per year.

While this estimate is not subject to direct verification, its amount appears to be reasonable in relation to the over-all conditions in this area. It has been used in the trial balance of supply and demand. It represents the estimated amount of such ground water movement under conditions of average precipitation. The time required for such movement from the areas of origin to the valley largely equalizes the annual variations in its amount. This item has not been materially affected by development in the hill areas and should change only slowly in the future.

Ground Water Inflow From Beneath San Francisco Bay

Draft in the Pressure Area has lowered the ground water there below sea level. There is now a gradient from the Bay toward the Pressure Area having a total difference in elevation of over 100 feet. Under such a gradient movement of ground water from under the Bay to the Pressure Area is occurring.

To date such movement has not resulted in salt water intrusion into the Pressure Area. The water moving from under the Bay does not create a vacuum as it moves and it must be replaced by other water. Such replacement water is drawn from the general body of ground water under the Bay. This general body of ground water may be replenished from tributary sources around the Bay, if such sources exist under present conditions of draft. If not replaced by some source of fresh water, eventually the withdrawal of fresh water from under the Bay will be replaced by salt water.

The present ground water conditions in the Pressure Area represent a threat of salt water intrusion. Fortunately this has not occurred to date but the existing conditions should be changed to reverse the ground water gradient and to remove this threat.

The movement of ground water from under the Bay is a present source of supply which needs to be included in any balance of supply and draft. It cannot be measured and only generalized estimates of its amount can be made.

Past estimates have included 8,000 acre-feet per year in Bulletin 7 for the period 1936 to 1948. The gradient landward of the ground water during this period was much less than it is at present. Recovery above sea level occurred during parts of these earlier years; the present trough is continuous. Present ground water movement probably exceeds 15,000 acre-feet per year. For the trial balance of supply and draft a mean inflow of 15,000 acre-feet for 1952-59 and 20,000 acre-feet for 1960 has been used.

Past Imported Water Supplies

In recent years some water has been received in North Santa Clara County by purchase from the City of San Francisco. This imported water has been used by cities in the Pressure Area to reduce their draft on the underlying ground water and represents an item that needs to be included in the balance between supply and demand.

The total amounts of such deliveries from 1945 to 1956 are listed in the report of Perrott and Dunn of March 1957. These results appear to be for the calendar years. Total deliveries for the fiscal years 1957-58 to 1959-60 were made available by San Francisco. The deliveries for the first half of 1957 were not secured.

From these results the mean annual delivery for the eight years, 1952 to 1959, was about 5,400 acre-feet. For the fiscal year 1959-60 the total deliveries were 13,300 acre-feet.

Estimated Total Water Supply

The elements of the water supply available to the North Santa Clara Valley for the period 1952 to 1959 and the mean annual supply for conditions in 1960 have been discussed and their amounts estimated. These have been assembled in Table 3. As previously stated, some of these items cannot be directly measured and are subject to probable errors of varying amounts.

The results in Table 3 for the eight years 1952-59 are the historical items of supply available during this period to meet the draft. Runoff stored but not used is not included. For the 1960 conditions, the annual historical storage is added to the stream flow to give the mean annual stream flow which would be available to meet long time drafts when all storage is used.

The results in Table 3 for 1960 represent the estimated mean annual supply available under the existing conditions in 1960. It exceeds the mean annual supply for 1952-59 by the increase in stream flow resulting from full use of storage, by the increase in water purchased from San Francisco, and the increased ground water inflow from beneath San Francisco Bay induced by the increase in ground water slope. It is less than the mean for 1952-59 by the amount of the reduction in rainfall penetration resulting from the increased urbanization.

TABLE 3

ELEMENTS OF WATER SUPPLY OF NORTH SANTA CLARA VALLEY

Estimated Amounts of the Several Sources
of Supply in Thousands of Acre-Feet

Item	Means for 8 Years 1952-59	Mean for 1960 Conditions
Surface Stream Inflow	202.4	210.0
Surface Stream Outflow	73.7	73.7
Net Supply from Surface Streams	128.7	136.3
Deep percolation of rainfall on the Valley Area	27.0	24.0
Percolation from perched water table in Pressure Area	40.0	40.0
Ground water movement from adjacent Hills	16.2	16.2
Imported supply purchased from San Francisco	5.4	13.3
Water of compaction resulting from subsidence	14.0	14.0
Ground water inflow from beneath San Francisco Bay	15.0	20.0
TOTAL	246.3	263.8

Cloud Seeding

Cloud seeding in an effort to increase local precipitation has been practiced for some years. The results have been considered to be sufficiently favorable for the practice to be continued.

This work for the three winters starting with 1955-56 is discussed in a paper by A. S. Dennis published in the Journal of the Irrigation and Drainage Division of the American Society of Civil Engineers for March 1960. An increase in rainfall due to cloud seeding of 15 to 28 per cent of the expected rainfall is claimed in this article. The target area was the drainage areas south of San Jose and the control area was along the coast from Salinas to San Francisco including East Bay stations. The author concluded that increases in rainfall in parts of Santa Clara County designated as the target area for cloud seeding have been demonstrated "beyond any reasonable doubt". For the three years studied the claimed increase over the whole target area was a total depth of rainfall of 11.65 inches.

This article refers to conditions in Santa Barbara County. It is stated that, in general, conditions during winter storms in the Santa Clara area conform to findings by R. D. Elliott in Santa Barbara County. Cloud seeding in the Santa Barbara area under cooperative agreements between several agencies has been practiced for several years. As a result of its analysis of the results, the State, as one of the cooperating agencies, has recently withdrawn from further participation in this operation.

Committee Print No. 22 of the Select Committee on National Water Resources of the U. S. Senate pursuant to S. Res. 48, 86th Congress, entitled "Weather Modification" includes the following statement in its foreword:

> "More than $10 million and many years have been devoted to these studies. They have included many thousands of field tests in hundreds of localities, in more than a score of countries, and on every continent. Despite all these intensive efforts, manmade rain is not yet a realiable and proven source of water for localities where an increase in water supply is vital. But this is not lost effort, for it is placing research in weather modification and rainmaking on a scientific basis far ahead of the meager knowledge at hand when modern tests were begun over 12 years ago."

In view of the uncertainties regarding the results that may be obtainable from such operations it is concluded that plans for securing the additional water supply which will be needed in North Santa Clara County should proceed without consideration of cloud seeding as a possible source for such needed water.

The process of cloud seeding is relatively inexpensive in relation to the area tested. Its practice can be continued if desired but it is not considered to be a solution for the existing water needs of this area.

Reuse of Sewage

Municipal and industrial sewage is now and will become an increasing item in the outflow from North Santa Clara Valley as urbanization increases. The sewage of San Jose and Santa Clara is now treated at a location from which it can be pumped back to areas where it can be percolated to the ground water. Such pumping is now proposed by the Conservation District. The sewage of the cities in the northern part of the valley is not collected where it can be as readily placed in the ground water and it will probably continue to be discharged to San Francisco Bay.

In the report of the Conservation District on the Revised 1956 Waste Water Salvage Project, the then output of the San Jose sewage treatment plant was estimated to be 30,000 acre-feet per year. This output will continue to increase as the municipal use of water by San Jose and Santa Clara expands. The extent to which it may be usable will depend first on its quality and the degree of treatment and secondly on the percolation capacity of available spreading grounds.

Use of reclaimed sewage for surface irrigation does not represent a probable permanent use. Some use might be made at the present time from adequately treated sewage for irrigation on lands in the vicinity of the sewage treatment plant. This would require surface distribution systems having relatively high costs for rights of way and construction. If, as expected, this area becomes urbanized such irrigation systems might not be adapted for use in the municipal and industrial systems.

Surface irrigation using reclaimed sewage directly does not appear to represent a material or permanent replacement for the present ground water draft in this area.

Use of reclaimed sewage for ground water recharge requires its conveyance to areas where the ground water is unconfined in which percolation areas are available. The areas best meeting these standards are along Penitencia Creek. The Conservation District has proposed such a project in its July 12, 1960, report.

This project includes a pumping plant on Coyote Creek from which water would be lifted nearly 300 feet through about eight miles of pipe to spreading grounds on Penitencia Creek. The capacity of the pipe line would be 40 second-feet and it would be operated 10 months of the year to deliver about 21,000 acre-feet. Based on a 25 year bond issue at 4-1/2 per cent interest and the estimated costs of pumping and maintenance and operation, the estimated cost per acre-foot would be $10.00 during the bond repayment period and $4.00 per acre-foot for the next 25 years giving an average cost over the first 50 years of use of $7.00 per acre-foot delivered to existing percolation ponds.

The present treatment of this sewage, is not sufficient for use of the plant effluent for ground water recharge. The pumping plant on Coyote Creek could divert available water in the creek until San Jose adds secondary and teritary treatment to its present plant. The use of reclaimed sewage is based on providing sufficient treatment to produce a quality of effluent which will be approved by the State for percolation.

The present Penitencia Creek percolation ponds consist of the right of way of the former railroad to Alum Park. When this railroad was abandoned its right of way was excavated to form a ditch with drops into which water from Penitencia Creek is diverted for percolation. As there is no storage in which the flow of the creek can be regulated and settled to provide clear water for percolation, much of the runoff has not been usable. During the 20 years of such operation a total of 18,000 acre-feet is reported to have been percolated. For past irregular operations a rate of percolation of five feet depth per day has been reported. To percolate 21,000 acre-feet per year would require a minimum ponding area of 16 acres at this rate of percolation.

San Jose is planning additional treatment of its sewage, including the sewage of Santa Clara, which is being designed to produce an effluent suitable for discharge into the Bay which may be usable for percolation to the ground water. A vote upon bonds for such a $20,000,000 program is proposed for early in 1961. As such works are essential in order to meet the present requirements relating to pollution of San Francisco Bay, the treatment planned will be needed whether the effluent is used for percolation or wasted. In recognition of the advantages it would gain from the availability of such treated water, the Conservation District has agreed to acquire, for use by San Jose, the 1,000 acres of aeration ponds required for this treatment. These ponds will be located on tidal lands and their effluent will require pumping back from greater distances than now planned in the July 12, 1960, report.

Ground Water Storage in North Santa Clara Valley

The variable annual recharge of the ground water in North Santa Clara Valley is equalized in the ground water storage in the valley fill. Relatively large variations have occurred in the depth to ground water as the conditions of supply and draft have varied over the past years.

The records of the average fluctuations for the entire valley have been assembled by the Conservation District. Since its organization in 1929 these records have been secured by this District. These have been plotted in diagrams which have been included in several available reports and the results for the average elevation of the ground water for the entire valley by months have been made available.

The State in its Bulletin 7 has also prepared results for the average depth to ground water for the area of the Forebay only. As the changes in ground water volume are limited to the Forebay, except as the lowering may become large enough to actually unwater part of the Pressure strata, the ground water fluctuations in the Forebay are a more direct measure of the change in volume of ground water storage than the fluctuations for the entire area.

The difference in the average depths to ground water derived by these two agencies is illustrated by the following results:

Mean Depth to Ground Water in North Santa Clara Valley
Based on Records in the Fall of the Year - In Feet

	Results of Conservation District For Entire Valley		Results of State For Forebay Only	
Year	Mean Depth To Ground Water	Change Between Dates	Mean Depth To Ground Water	Change Between Dates
1916	23			
		-116		
34	139		109	
		+83		+49
43	56		60	
		-108		-80
50	164		139.6	
		+24		+38
53	140		101.8	
		+ 6		
59	134			
Total Period 1934-53		- 1		+ 7

The preceding comparison shows that the ground water in the entire valley reacts to variations in the water supply at a different rate than the Forebay alone. For the 20 years of common record from 1934 to 1953 the total variation was in fairly good agreement but the amplitude of the variations in the Forebay was less than that in the entire valley. For changes in ground water storage for periods of a few years, fluctuations in the ground water in the Forebay only represent a better basis than those for the entire valley.

The volume of ground water storage represented by changes in ground water elevation has been derived from records of well logs and estimates of the specific yield of the different types of material reported in the well logs. Such estimates have been made by the State in Bulletin 7 and by Creegan and D'Angelo for the Authority.

In Bulletin 7 the State found an average specific yield of 7.4 per cent for all depths. When applied to the State's results for the area of the Forebay of 86,500 acres this represents 6,400 acre-feet of ground water storage per foot of depth.

Creegan and D'Angelo in Appendix A of their August 1960 report on "Northern Santa Clara Valley Water Demand" derived a percentage of gravel shown in the well logs for each 10 foot variation in depth and from these results derived a variable specific yield for different depths. Their results are plotted on page 12 of this report. For depth to ground water from 60 to 160 feet they found the per cents of gravel varying from about 11 to 23 per cent and acre-feet per foot of depth of ground water storage varying from about 2,500 to nearly 6,000 acre-feet. For ground water storage between depths of 60 and 160 feet, this report derived a usable storage capacity of 447,200 acre-feet. For the same change in depth the State's results in Bulletin 7 would be a storage capacity of 640,000 acre-feet.

Any estimate of ground water storage capacity is subject to a large probable error. The available well logs are not uniform in their detail or dependability. Specific yields vary with variations in the texture of materials reported as sands or gravels.

If the ground water had a uniform depth over the entire storage area and fluctuated uniformly, derivation of storage capacities by different depths would be applicable. As the actual ground water depths over the area vary at any one time and as some areas may rise while others fall, it is doubtful if the refinement represented by the use of variable storage capacities for different depths is justified.

The preceding results, while having a considerable difference in their method of derivation and resulting storage capacity, support two conclusions. Both results show a large volume of available ground water storage within an economically feasible range of fluctuation. Both emphasize the advantage, in balancing supply and demand, of selecting periods having minimum average changes in ground water elevation so as to reduce the amount of this uncertain item to a minimum.

While the ground water depletion which has occurred has lowered the ground water over 100 feet below its 1916 elevation, the ground water storage has not been exhausted. While the alluvial fills in the Valley are relatively deep, the practical extent to which the ground water storage can be used is controlled by the cost of pumping and the danger of salt water intrusion. It is considered that the practical limit of usefulness of the ground water will be reached when it has an average depth of 160 feet.

From the results which have been discussed it has been concluded that maintaining the mean annual depth to ground water in the Forebay between depths of 60 and 140 feet will make available ground water storage capacity of the probable order of 500,000 acre-feet.

This volume of local ground water storage will be adequate to regulate the annual variations in local runoff. The imported supplies now under consideration will be regulated at their source and will not vary so widely in their annual amounts.

It is also concluded that at present there is a depletion in the past ground water storage of perhaps 400,000 acre feet. It will be necessary to replace much, if not all, of this depletion in the Forebay if the ground water gradient into the Pressure Area is to be restored so that pressures there can prevent further subsidence and ground water inflow from beneath San Francisco Bay. While the locally available sources of supply are inadequate to accomplish this replacement under the present draft, whenever imported supplies may become available for use in the Forebay, the present spreading areas should be increased and the maximum amounts of imported water that can be put underground should be used.

QUALITY OF PRESENT AND PROPOSED WATER SUPPLIES

The local and the proposed imported water supplies generally meet current standards of mineral quality for irrigation and municipal use. Some ground water supplies in areas near the Bay have deteriorated under overdraft and the present draft is limited to the usable supply which can be secured. Water which may be imported from the Delta will be of usable quality as protection against salt water intrusion at the points of diversion from the Delta is a requirement for all projects using water from the Delta Pool.

As long as the ground water is below sea level in much of North Santa Clara Valley there will be a danger that there will be salt water intrusion from the Bay. To date this has not occurred. This risk can only be removed by raising the ground water above sea level so that the ground water gradient is toward the Bay.

USES OF WATER

The various uses of water for the eight years 1952-59 and for 1960 have been assembled on a similar basis to that used for the different items of supply. Each use is discussed followed by a total for all uses. Like the elements of water supply, some of the items of use are not subject to direct measurement and have to be based on estimates which utilize the measurements that can be made and general experience for the remainder.

Water Requirements for Irrigation

The areas irrigated were surveyed in 1949 by the State in its work on Bulletin 7. A similar survey was made by the Santa Clara County Planning Division in 1956.

The U. S. Bureau of Reclamation has used these results with the areas of the different crops and estimates of the use of water per acre to derive preliminary estimates of the total use for irrigation. For the unconfined area the consumptive irrigation requirements plus 10 per cent was used as the net ground water draft. For the confined area where it was considered that deep percolation losses did not occur, except as recharge for the semi-perched water table, the farm delivery demand was used as the draft. The areas irrigated had been separately determined for the unconfined and confined areas as these areas had been defined by the Bureau. This procedure derived what was termed the net water requirement for irrigation for these two areas for these two years.

For the intervening years, the changes from 1949 to 1956 were assumed to have occurred at a uniform rate. The same rate of change was projected to 1958 to complete estimates from which the mean draft for the six years, 1953 to 1958, could be computed.

The Review Board has used the same method to derive the mean draft for the eight years, 1952 to 1959, and for 1960. The estimates as shown in Table 4 have been used as the draft for irrigation for these years. Table 4 also shows the estimated draft for municipal and industrial use derived by the Bureau which is discussed later.

Water Requirements for Municipal and Industrial Use

The draft for municipal and industrial use was also computed by the Bureau from surveys made in 1949 and 1956. The gross drafts are shown in Table 4 with the irrigation drafts.

Of these gross drafts about one-half would represent inside uses which reach the sewers with little consumptive use. Of the outside uses part would percolate to rejoin the ground water in the unconfined area. In the confined area part would also percolate to the perched water table where the percolation from the perched water table has already been estimated as an item of supply.

The Review Board has estimated that the gross draft for municipal and industrial uses in the Pressure Area is also the net draft on the above basis. For the Forebay Area it has estimated that one-half of the gross draft reaches the sewers and does not return to the ground water and that

TABLE 4

DRAFT IN NORTH SANTA CLARA VALLEY - ESTIMATES OF U. S. BUREAU OF RECLAMATION EXTENDED TO 1960

Thousands of Acre-Feet

	Unconfined Area			Confined Area			Total Area		
Year	Agric-ultural	M & I (1)	Total	Agric-ultural	M & I (1)	Total	Agric-ultural	M & I (1)	Total
1949	68.0	*12.0	80.0	88.7	*29.0	117.7	156.7	41.0	197.7
1950	*68.3	14.6	82.9	*86.9	34.5	121.4	155.2	49.1	204.3
1951	*68.6	17.2	85.8	*85.1	40.1	125.1	153.7	57.2	210.9
1952	*68.9	19.7	88.6	*83.3	45.5	128.8	152.2	65.2	217.4
1953	*69.2	22.2	91.4	*81.5	51.0	132.5	150.7	73.2	223.9
1954	*69.5	24.6	94.1	*79.7	56.4	136.1	149.2	81.0	230.2
1955	*69.8	27.1	96.9	*77.9	61.9	139.8	147.7	89.0	236.7
1956	70.0	29.6	99.6	76.0	67.3	143.3	146.0	96.9	242.9
1957	*70.3	32.1	103.4	*74.2	72.9	147.1	144.5	105.0	249.5
1958	*70.6	34.6	105.2	*73.4	78.3	151.7	144.0	112.9	256.9
1959	*70.9	37.1	108.0	*71.7	83.8	155.5	142.6	120.9	263.5
1960	*71.2	39.6	110.8	*70.0	89.3	159.3	141.2	128.9	270.1
11 years									
Total	835.3	310.4	1145.6	948.4	709.8	1658.3	1783.7	1020.3	2804.0
Mean	75.9	28.2	104.1	86.2	64.6	150.8	162.1	92.7	254.8
6 years									
1953-58									
Mean	69.9	28.4	98.3	77.1	64.6	141.7	147.0	93.0	240.0
8 years									
1952-59									
Mean	70.0	28.4	98.4	77.2	64.6	141.8	147.1	93.0	240.1

Gross Areas Used - Acres	USBR	DWR
Unconfined	76,400	86,500
Confined	87,300	78,600
Total	163,700	165,100

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(1) Gross Draft - One-fourth estimated to return to ground water in Forebay.

* Interpolated.

one-half of the outside uses is consumptively used and one-half (equal to 25 per cent of the gross draft) percolates to the ground water. On the basis of these assumptions the net draft in the Forebay Area is 75 per cent of the gross draft.

The estimates of the Review Board for the net draft for municipal and industrial purposes are as follows:-

	Annual Draft in Thousands of Acre-Feet		
Mean Net Draft for	Forebay Area	Pressure Area	Total
1953-58 - 6 years	21.3	64.6	85.9
1952-59 - 8 years	21.3	64.6	85.9
1960	29.6	89.3	128.9

Total Ground Water Draft

The total net draft for irrigation, municipal and industrial use as derived in the preceding discussion is as follows:

	Annual Draft in Thousands of Acre-Feet		
Period	Forebay Area	Pressure Area	Total
1952-59	91.2	141.8	233.0
1960	100.8	159.8	270.1

Subsurface Outflow to South Santa Clara Valley

The ground water slopes to the south at the divide between the North and the South Santa Clara Valleys. Some movement of ground water occurs which is supplied from the North Santa Clara Valley. While small in its total amount, it represents an item in the water supply balance of North Santa Clara

Valley which should be taken into account. In Bulletin 7, the State (p. 38) estimated the mean annual amount of this flow to be 2,700 acre-feet. Based on the more extensive records now available the Bureau has estimated this flow to be 3,800 acre-feet per year. The Review Board has used this later estimate.

Total Use of Water

The elements of water use have been assembled in Table 5. These show an increase in estimated use in 1960 over the mean for 1952-59 of 37,100 acre-feet. The reduction in irrigation use was more than offset by the increase in municipal and industrial use.

TABLE 5

ELEMENTS OF WATER USE IN NORTH SANTA CLARA VALLEY

Estimated Amounts of the Several Sources
of Supply in Thousands of Acre-Feet

Item	Means for 8 Years - 1952-59	Results for 1960
Net Draft for use for irrigation	147.1	141.2
Municipal and industrial use	85.9	128.9
TOTAL	233.0	270.1
Ground water outflow to South Santa Clara Valley	3.8	3.8
TOTAL USE OF WATER	236.8	273.9

The draft on the ground water in North Santa Clara Valley by years from 1951 to 1960 has also been estimated in the report of the Conservation District of July 12, 1960, on "Additional Conservation and Distribution Facilities". In this report the drafts for municipal, agricultural, and industrial uses were estimated separately. The industrial use derived is that by industries having their own wells. Industrial use received through municipal systems is included in the municipal use. These estimates are as follows:

Use	Annual Estimates in Acre-Feet Mean for 8 Years 1952-59	 1960
Municipal	69,800	108,900
Agriculture	113,800	97,400
Industry	17,800	20,000
Total	201,400	226,300

These estimated totals are about 15 per cent less than those derived in Table 5. The drafts for municipal and industrial uses are in close agreement; the difference is nearly all in the use for irrigation. The agricultural use of water in the July 12, 1960, report of the Conservation District was derived by using the estimate of the State in Table 34 of Bulletin 7 for a use in 1948 of 141,000 acre-feet and deducting the estimated use of lands which had changed from irrigation to urban use since 1948. The area irrigated in 1948 shown in Table 34 of Bulletin 7 is 92,300 acres, that used for the results in Table 5 for 1949 was 100,400 acres and for 1956 was 94,300 acres. The difference between the results for agricultural draft in the July 12, 1960, report of the Conservation District and draft used by the Bureau is the result of differences in both the area irrigated and in the rate of use per acre. For the trial balance of supply and use the Review Board has used the results of the Bureau.

CHANGE IN GROUND WATER STORAGE

A balance of supply and draft for any time period requires the inclusion of an item for the change in ground water storage that may have occurred during this period. To reduce the effect of any errors in estimating the specific yield for any changes in ground water elevations, it is desirable to use periods in which a minimum change has occurred in the ground water elevations.

The 8 year period 1951-52 to 1958-59 inclusive has been used to represent years having average precipitation and the recent and present draft. During this period some rise occurred in the average elevation of the ground water in the Forebay. Changes in the elevation of the ground water in wells in the Pressure Area are assumed to represent changes in pressure and not in the ground water volume. From the fall of 1951 to the fall of 1959, the District has computed an average rise of the ground water in the entire valley of 22.1 feet. The District has also derived an increase in the volume of ground water storage for this eight year period of 148,500 acre-feet based on an average value of the change in volume of ground water per foot of depth of about 6,800 acre-feet. These results represent an average increase in ground water storage of 18,500 acre-feet per year for this 8-year period having an average precipitation. This represents an element of supply for this period.

For 1960 the preliminary estimates of the Conservation District show a lowering of the ground water elevation for the entire area of about 10 feet. This represents an estimated reduction in the ground water storage of 68,000 acre-feet for this year.

In comparison of supply and use for 1952-59 the increase in the volume of ground water storage represents the excess of the mean supply over the demand under the conditions existing during these years. For 1960 the decrease in the volume of ground water storage represents a deficiency in supply which had to be secured from the depletion of the ground water.

BALANCE OF GROUND WATER SUPPLY AND DRAFT

The various elements of the ground water supply and draft have been discussed. These can be brought together to furnish the basis for an estimate of the balance between the supply and draft.

If all items involved could be measured directly, the accounting for supply and use would be definite. All results based on such measurements should agree. This condition is not applicable to the North Santa Clara Valley and the exercise of judgment is required in the selection of the amounts of some of the items used. The results which have been used by the Review Board have been discussed in the preceding portions of this report. The source of the items used is reviewed in the following discussion.

The purpose of such a balance is to define the excess or deficiency of the supply in relation to the use. If all results are correct the difference will be the overdraft if use exceeds supply or the remaining available supply if supply exceeds the use.

For this comparison, results have been derived for two periods. The mean for the eight years, 1952-59, has been used as representing a period of nearly average precipitation in the area when the present works of the Conservation District were in operation. Records for earlier years do not include the additional supply provided by Anderson and Lexington Reservoirs. For these eight years the precipitation at San Jose was 101 per cent of the long time mean.

The second comparison made is for the conditions of use in 1960 with the average conditions of water supply rather than the actual supply in 1960. This represents the results to be expected under the present amounts of draft. The actual supply in 1960 included that received in a year having less than mean precipitation increased by the release and percolation of storage carried over from 1959 of about 45,000 acre-feet. The results for 1960 in Table 6 are the balance between the actual draft and the mean supply. The draft in 1960 exceeds the mean draft for 1952-59. Conclusions drawn on the basis of the mean for 1952-59 would not be applicable under the increased draft in 1960.

The values of the elements of supply have been previously discussed. The absorption from stream channels is the result of the measurement of stream inflow and outflow. The results for the ground water inflow from adjacent areas is that derived by the State in its Bulletin 7. The rainfall penetration on the Forebay Area is the difference between the mean rainfall and the estimated consumptive use of rainfall using the results in Bulletin 7. The water of compaction and the ground water inflow from the Bay are based on the recent work of the Bureau of Reclamation. These are not items of permanent supply but were obtained under the conditions existing in the Pressure Area during these years.

The total estimated supply in Table 3 has been compared with the results for the total estimated use in Table 5 to derive an estimate of the surplus or overdraft that may exist for the periods used. This has been done in Table 6.

For the eight years 1952-59 Table 6 shows a total supply of about 3.8 per cent more than the use. This is well within the probable error to be expected in such derivations of the several elements of supply and use.

For 1959-60, preliminary estimates furnished by the Conservation District indicate an estimated ground water recharge of about 75,000 acre-feet and a ground water lowering of 10 feet representing a decrease in ground water storage of about 68,000 acre-feet. Using the other elements of supply shown in Table 3 which would be applicable in 1960, gives a total supply of 271,300 acre-feet. This is about 1% less than the estimated use in this year shown in Table 5. This again is a much closer agreement than would be expected in such comparisons.

TABLE 6

COMPARISON OF SUPPLY AND USE OF WATER IN NORTH SANTA CLARA COUNTY

Estimated Total Supply and Use in
Thousands of Acre-Feet

Item	Mean for 8 years 1952-59	1960
Total water supply for conditions in period	246.3	263.8(1)
Total uses of water	236.2	273.9
Available to be added to ground water storage	9.5	
Required to be taken from ground water storage		10.1
Actual change in ground water storage based on well records and estimated specific yield	+18.5	-68.0(2)
Indicated imbalance in items of supply and use	9.0	2.6(3)

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(1) Estimated mean annual supply with present works and conditions of use.

(2) Estimated actual reduction in ground storage in 1960.

(3) Not determinable until records of actual water supply for 1960 are available. Preliminary estimates indicate a difference in supply and use of 2,600 acre-feet.

BALANCE BETWEEN SUPPLY AND DEMAND IN FOREBAY AND PRESSURE AREAS

The estimates in Tables 1 to 6 compare the supply and use for the entire North Santa Clara Valley. The available records and estimates also enable similar balances to be made for the Forebay and Pressure Areas separately. Such separate balances are needed as the conditions governing the availability of the supply to meet the draft vary in these two main divisions of the North Santa Clara Valley. While these conditions also vary in the parts of both the Forebay and Pressure areas available records do not enable similar divisions of the supply and draft to be made for such smaller areas. Consideration of smaller areas will be required in any program for local works to balance their supply and draft.

The division of the Valley area between Forebay and Pressure conditions has been accepted in all investigations as a condition governing the ground water supply and draft. Changes in pressure in the Pressure Area have not been considered to represent changes in the volume of ground water storage. Reduction in elevation of water in the wells in much of the Pressure Area has continued in recent years while the ground water has risen in much of the Forebay.

While there has been agreement that there is a Forebay and Pressure Area, there has not been entire agreement regarding the division of the valley lands between these two areas. The results of the State used in Bulletin 7 and the recent results of the Bureau are shown at the bottom of Table 4. While these results for the total valley area are in good agreement the Bureau places about 9,000 acres more area in the confined or Pressure Area than the State.

The Bureau's results were derived in 1959 from a detailed study of well logs, well behavior, and subsidence using the additional data that had become available since 1955. It has been used by the Review Board. The Bureau's results for draft are based on its definition of this boundary.

Comparisons have been made for the historical conditions existing from 1952 to 1959 and for the uses of water in 1960 with the mean annual sources of supply. This comparison for 1960 differs from the actual record for this year as the mean annual supply was used instead of the actual 1960 supply. As the supply in 1960 was less than the annual mean, the results using the annual mean supply are more favorable than the historical results in 1960.

In both of these comparisons, separate estimates have been made for the Forebay and Pressure Areas. This enables the ground water movement from the Forebay to the Pressure Area to be estimated and the conditions in each area to be separately evaluated.

Estimates for 1952 to 1959

The estimated annual mean for the period 1952 to 1959 are assembled in Table 7. This 8-year period had about average precipitation. The available records and estimates enable the ground water response to the draft to be evaluated.

In Table 7 the items of draft are those derived by the Bureau as shown in Table 4. The items of supply are taken from Table 3 segregated between the Forebay and Pressure Areas. In Table 6, the balance of supply and use shows that the ground water storage should have increased an average of 9,500 acre-feet per year; actually it increased 18,500 acre-feet per year. This error is assumed to have been in the estimates of use; these have been adjusted in Table 7 to equal the supply by a reduction of 3.8 per cent. The difference in supply and use for this period is reflected in the change in ground water storage and this adjustment brings the supply and use into harmony with the change in ground water storage that actually occurred.

Over-all, for this period, for the entire North Santa Clara Valley there was an excess of supply over draft of 18,500 acre-feet per year as shown by the increase in ground water storage during this period.

Table 7 also indicates that an average of 61,900 acre-feet per year moved from the Forebay to the Pressure Area. The transmissibility was not sufficient to move all of the excess supply received by the Forebay to the Pressure Area and the surplus accumulated in the Forebay.

While the total supply from all sources exceeded the draft, part of the draft in the Pressure Area had to be met from local sources which are not permanent and by surface importation. These combined items have an estimated total of 29,400 acre-feet.

For the average conditions during this 8-year period a surface supply in addition to the permanent ground water supply in the Pressure Area of about 30,000 acre-feet was needed. With this supply in the Pressure Area and the draft during this period, the Forebay would continue to increase its volume of ground water storage and to replace the depletion that had occurred

TABLE 7

ESTIMATED SUPPLY AND DRAFT FROM FOREBAY AND PRESSURE AREAS OF NORTH SANTA CLARA VALLEY

Annual Means for 8-Year Period 1952-59
In Thousands of Acre-Feet

	Forebay Area	Pressure Area	Total
Items of Net Draft			
Irrigation	70.0	77.1	147.1
Municipal & industrial use	21.3	64.6	85.9
Ground water outflow to South Santa Clara Valley	3.8	0	3.8
Total Use of Supply Accounted For	95.1	141.7	236.8
Items of Water Supply			
Surface stream inflow less outflow	128.7		128.7
Deep percolation of rainfall	27.0		27.0
Percolation from perched ground water		40.0	40.0
Ground water movement from adjacent hills	16.2		16.2
Imported supply		5.4	5.4
Water of compaction		14.0	14.0
Ground water from beneath San Francisco Bay		15.0	15.0
Total Items of Supply	171.9	74.4	246.3
Total use adjusted to equal total supply - -3.8% from Table 6	91.5	136.3	227.8
Total Supply Less Adjusted Total Use	+80.4	-61.9	+18.5
Indicated movement from Forebay to Pressure Area	61.9	61.9	
Actual change in ground water storage for period	+18.5	0	+18.5
Indicated surplus (+) or deficiency (-)	+18.5	0	+18.5
Items of supply not supplied by permanent local sources -			
Water of compaction and movement from beneath S. F. Bay		29.0	
Imported supply		5.4	
TOTAL		34.4	

prior to 1951-52.

It is concluded from these results that a mean annual additional source of supply deliverable to meet the draft in the Pressure Area of 30,000 acre-feet per year was needed during this period and, if it had been available, should have been secured.

These results indicate that the storage and spreading works in use during 1952 to 1959 provided sufficient percolation in the Forebay to meet its draft but that the transmissibility of the ground water strata under the then existing slopes was insufficient to convey all of the ground water recharge in the Forebay to the areas of draft in the Pressure Area. This physical condition has importance in relation to the methods that may be used to meet the demand in the Pressure Area. For this period ground water recharge met the draft in the Forebay and continued and increased recharge there can meet its increasing draft until the draft reaches the recharge capacity. While this statement is applicable to the Forebay as a whole it is not directly applicable to all of its parts and additional recharge is now needed in some local and marginal areas in the Forebay.

Estimates for 1960 Conditions

Similar comparisons to those shown in Table 7 for the period 1952 to 1959 are shown in Table 8 for the conditions of draft in 1960 and the mean annual water supply. The demand in 1960 was larger than the mean for 1952-59. Under average conditions all of the surface storage would be percolated so that the expected mean annual supply includes the storage accumulated historically in 1952 to 1959. There are also some changes in other items resulting from changed conditions of use in 1960 from the mean for 1952 to 1959.

Over-all, the estimated total draft in 1960 appears to be closely equal to the estimated total sources of supply. For this draft and these mean annual items of supply there would be neither ground water accretion or depletion in the entire valley as a whole.

The results in Table 8 indicate that, to meet the draft in the Pressure Area, a ground water movement from the Forebay of 71,800 acre-feet per year would be needed. In Table 7 the similar mean annual movement for 1952 to 1959 is 61,900 acre-feet per year. For the eight years 1952 to 1959 the ground water in the Forebay rose thus increasing the slope toward the Pressure Area. To supply the draft from the Pressure Area in 1960, this indicated movement would need to be about 10,000 acre-feet per year larger than the mean for 1952-59. There is no basis on which the amount of any such increase can be computed but this difference is in the direction in which the change would occur.

Under the draft in 1960, with present storage and spreading works, the Forebay appears to be able to meet its draft with average water supply. For the Pressure Area there appears to be a shortage in the local sources of permanent supply of about 50,000 acre-feet per year. For such present conditions the ground water in the Forebay would vary with the character of the individual years but, as an average, would be expected to remain at about its present elevation.

TABLE 8

ESTIMATED SUPPLY AND DRAFT FROM FOREBAY AND PRESSURE AREAS OF NORTH SANTA CLARA VALLEY FOR CONDITIONS OF AVERAGE WATER SUPPLY AND USES OF WATER IN 1960

In Thousands of Acre-Feet

	Forebay Area	Pressure Area	Total
Items of Net Draft			
1. Irrigation	71.2	70.0	141.2
2. Municipal and industrial use (assumed 3/4 of gross draft in Forebay)	29.7	89.3	119.0
3. Ground water outflow to South Santa Clara Valley	3.8		3.8
4. Total use of water accounted for	104.7	159.3	264.0
Items of Water Supply			
5. Surface stream flow less outflow	136.3	0	136.3
6. Deep percolation of rainfall	24.0		24.0
7. Percolation from perched ground water		40.0	40.0
8. Ground water movement from adjacent hills	16.2		16.2
9. Imported supply		13.3	13.3
10. Water of compaction		14.0	14.0
11. Ground water from beneath San Francisco Bay		20.0	20.0
12. Total Items of Supply	176.5	87.3	263.8
13. Indicated movement from Forebay to Pressure Area	-71.8	+71.8	0
14. Indicated surplus (+) or overdraft (-)	0	0	0
Items of supply not supplied by permanent local sources			
Items 10 and 11		34.0	
Item 9 - Imported water		13.3	
Total Use Not Received from Permanent Local Sources		47.3	

Water to meet any overdraft existing in 1960 should be sought from the best available source. In considering the amount of such additional water, it will not be enough to merely maintain the 1960 ground water elevations. Replacement should be sought for the present items of supply represented by subsidence and by inflow from beneath San Francisco Bay. Consideration should also be given to the expected decrease in percolation from rainfall now resulting from urbanization of areas previously used for agriculture. In deriving the present overdraft on the sources of local water supply, present imported supplies should be deducted.

On this basis the present draft appears to exceed the permanent local supply as now developed by the following amounts: -

	Acre-Feet
Water of Compaction resulting from Subsidence	14,000
Ground Water Movement from beneath San Francisco Bay	20,000
Estimated reduction in Rainfall Percolation resulting from Urbanization	10,000
Present Imported Supplies	15,000
TOTAL	59,000

It is concluded that, with the continuation of the present imported supply of about 15,000 acre-feet per year, an additional source of about 50,000 acre-feet per year is now needed for the North Santa Clara Valley delivered where it will meet the draft from the Pressure Area. Any project now undertaken to provide such a supply should include capacity with which to meet the increasing needs for a period in the future for which it will be economical to make present provision. Such a reasonable period may be 20 years.

The State in its South Bay Aqueduct has planned delivery capacity for Santa Clara County at Airpoint of 88,000 acre-feet per year for the initial stage. This represents a reasonable margin over present needs and it has been used later in comparisons between securing water from the different available sources.

The preceding results and conclusions apply to the Forebay and Pressure Areas of the North Santa Clara Valley as a whole and do not consider the conditions affecting the different parts of each of these areas. In any plans for increased water supply consideration will need to be given to both the local areas where it is needed and to the extent to which it can be delivered by ground water recharge or to which surface service will be required. These requirements are discussed later in connection with the plans for the different sources of imported water which may be available.

FUTURE WATER DEMANDS

The preceding discussion has covered past use and water supply with conclusions regarding the present needs for additional water. Any program for meeting present needs should include provisions for the increased needs that will result from future increases in use.

Several different estimates have been made both of past and future demands. Results for past use rest on measurements of areas irrigated, urban use and other observable items. Rates of use can be derived from known conditions of past use. Forecasts for future use are necessarily more uncertain. Use is changing from agriculture to urban and rates of use are being affected by changes in practices. There is uncertainty regarding the rate of future increases in the water demands.

There is a fairly good agreement regarding the amount of past use. This is to be expected as such results rest in part on actual records. A similar agreement is not shown by the forecasts for the future. These cover a wide range depending on the optimism or conservatism of the estimator.

All forecasters agree that there will be a large increase in population and water use in this area. The differences relate mainly to the rate at which they will occur.

Some estimates of future needs have been extended as far as the year 2020. At this date the different estimates cover a wide spread. Instead of attempting a forecast of its own, the Review Board reviewed the estimates of others and accepted their general conclusions that a large increase in water use will occur. The Board then directed its attention to the differences in time when given amounts of increased supply were estimated to be needed.

Present planning is primarily concerned with provisions to meet the needs of some reasonable period in the future with present programs adapted to expansion when additional water may be needed. If provisions are now made to meet the demands which it is expected may occur in the next 20 years, future engineers can best determine the supply to meet additional demands.

Future programming of construction can be done much more readily as the time when additional water may be needed approaches.

The above basis assumes that there will be sources of water supply which will be obtainable when the need for their use is reached. General state inventories of supply and demand indicate that the over-all state supplies exceed the over-all future demands. The Santa Clara Valley is well located in relation to the areas of excess water supply. It is not considered that this area needs, at this time, to incur costs to acquire sources of water supply to meet its ultimate demands. Sources of supply adequate to meet the expected demands of the coming 20 to 30 years will protect present development and leave the selection of future sources to be made when the then conditions will be much better known.

The Review Board has approached its work on the above basis. The results of others forecasting use to 2020 have been reviewed but the recommendations of the Board have been based on its conclusions regarding the needs for the next 20 years.

A summary of the estimates that have been made in other reports is shown in Table 9. Twelve results are listed for different future times. For the present needs the various reports are generally within a reasonable range of the conclusions of the Review Board. For the future a wider range is shown.

It is the conclusion of the Review Board that North Santa Clara Valley will ultimately be developed to the full extent of its potential and that such development will be urban in character with its water demands for municipal and industrial use. The rate at which this will occur and the amounts of water that

TABLE 9

ESTIMATES OF IMPORTED WATER REQUIREMENTS OF NORTH SANTA CLARA VALLEY

Thousands of Acre-Feet

Source	Present-1960	1980	2000	2010 or 2020
Bulletin 7 - State Dept. Water Resources - June 1955	45.0			262.0
Perrott & Dunn - March 1957		120.0		355.0
Geo. L. Sullivan - May 1, 1957	40.0	80.0		160.0
Greydanus Report for State April 21, 1958	57.0	68.0	80.0	88.0
Design Report of State of June 27, 1958	57.0			88.0
Roll Report on Resolution - Jan. 13, 1959		80.0		160.0
Mark Thomas Report on Northern Municipal Needs - April 20, 1959		40.0		80.0
Santa Clara County Planning Div. - Oct. 14, 1959	67.0	105.0	193.0	263.0
Cline for State - Dec. 11, 1959	67.0	111.0	176.0	254.0
State's Information on South Bay Aqueduct - 3/11/60	66.0	83.0	117.0	179.0
Roll's Report on Additional Conservation & Distribution - 7/12/60	18.2			184.1
Creegan & D'Angelo - No. Santa Clara Valley Demand - August 1960	40.0	96.0	152.0	180.0

REVIEW BOARD'S CONCLUSIONS ON REQUIREMENTS FOR IMPORTED WATER

	1000 Acre-Feet
Requirement for additional water in 1960	50.0
Desirable capacity of first import unit	88.0
Probable need by 1980	88.0
Anticipated ultimate need for imported water	185.0

will then be required can only be a matter of present conjecture.

It is not necessary to assign an amount and date to the ultimate demands. Ultimate development will not be reached without adequate time in which to plan its various stages.

As previously discussed, it is the conclusion of the Review Board that the capacity for a first unit for imported water should meet the present overdraft on permanent sources of local supply of about 50,000 acre-feet plus a reasonable additional capacity to meet the expected increase in use during the next 20 years. The planned initial capacity for delivery to Santa Clara County of 88,000 acre-feet per year of the State's South Bay Aqueduct has been used as the basis for comparison of different sources of supply. Table 9 indicates that the demand will continue to increase after 1980 and imported water will be needed in excess of the capacity proposed for the first unit.

The correctness or error of the Review Board's forecast of future needs is not a major factor in decisions regarding present actions. The need for 88,000 acre-feet of imported water is within what may be termed the "foreseeable future". All other estimates recognize such a need with individual differences regarding when it will be required. The Review Board considers that, based on the information now available, a total need for imported water of from 180,000 to 200,000 acre-feet per year is a reasonable present forecast. Whether the actual total future need is more or less than these amounts will not affect decisions on present actions.

ABILITY TO SUPPLY DEMAND OF NORTH SANTA CLARA VALLEY FROM ITS GROUND WATER

In any consideration of sources of supply and methods of delivery of water to meet the present and future demands of the North Santa Clara Valley, it is essential that the ability to provide an adequate ground water supply either from natural or regulated sources be considered. If the physical conditions should prevent providing ground water at locations and in the amounts required to meet the demand, then ground water as a source of supply is eliminated for such locations. As ground water has been the historic source of supply for this area with present development adjusted to its use, it is natural that it should be preferred and its use should be continued to the extent to which it is or can be made available.

Even with available sources of water supply sufficient to meet its demands, the recharge of the ground water will be controlled by the local conditions affecting percolation and transmission underground to the places of desired draft. A primary consideration in any plan for imported sources of supply and their use is their adaptability for distribution underground or the necessity for using surface distribution.

The extent to which recharge in the Forebay would result in the transmission of sufficient ground water to the northern portions of the Pressure Area to meet its present and future demands has been extensively studied in the past. The records now available enable an adequate analysis of this problem to be made from which well supported conclusions can be drawn.

The North Santa Clara Valley has had a relatively long experience relating to its use of its local water supplies. Early orchards were planted with the expectation that irrigation would not be required. It was found that full production from mature trees required more moisture than could be secured from the rainfall alone. Pumping from wells began and became usual as the surface stream flow during summer months is negligible in amount.

This area prior to pumping had a large amount of ground water accumulated from the natural percolation from its stream channels and, in the Forebay, from direct rainfall penetration. This natural recharge had built up the ground water in the Forebay area so that artesian flow could be secured in much of the Pressure Area. Under prepumping conditions the ground water adjusted itself so that the ground water inflow to the Pressure Area, limited by the elevation of the perched water table, equalled the leakage through the clay cap. The early ground water slopes in the direction toward the bay like the land slopes, were relatively flat. Under predraft conditions the amount of ground water movement needed to replace losses from the Pressure Area moved into this area under the predraft slopes.

When pumping began in both the Forebay and Pressure areas the natural ground water conditions were materially changed. In the Pressure Area, the pumping draft required more inflow which could only be induced by steepening the ground water slope into the area. Such steepening could only be secured by loss of the artesian pressure as draft on the Forebay also lowered the elevation of its ground water. As draft increased this condition resulted in the pressure levels of the ground water in the northern part of the valley falling below sea level. In the earlier years the ground water trough thus created during the summer season of draft would recover above sea level during the winter. Continued increase in the draft resulted in a deeper trough which now remains throughout the year.

In the Forebay draft also lowered the ground water. Replenishment in much of the Forebay is direct and does not require transmission through the porous strata or aquifers for the distances which are required for the Pressure Area.

The loss of pressure and the ground water lowering became matters of local concern and investigations were begun by the U. S. Geological Survey in 1914. This work resulted in Water Supply Paper 519, published in 1924, which described the then conditions. Continued increase in draft and further ground water depletion resulted in the organization of the Santa Clara Valley Water Convervation District in 1929. The state made further investigations and published its results in 1933 in its Bulletin 42. Several other investigations have been made in recent years including the continuing work of the Conservation District. In 1934 the Conservation District voted bonds and began the construction of storage works to enable artificial recharge of the ground water to be made to supplement the natural recharge. The District's program and works were increased in 1950. These latter works have been in operation for the nine years since their completion. The records for this period furnish an adequate basis for analyzing their effect.

Experience in the use of ground water in this valley has shown that the major problem in supplying the water demand by pumping from wells is the adequate supply of water to the Forebay and the extent to which ground water in the Forebay can be transmitted through the Pressure Area to the points of draft. Such transmission is controlled by the area and porousity of the materials through which such flow can occur and also by the gradients that can be created by rising the elevation of the ground water in the Forebay. For the physical conditions in this area, experience has shown that the amount of ground water which can be transmitted to the points of draft in much of the northern part of the Pressure Area is less than the present draft. The present excess draft on this area has been supplied by water secured from inflow from under the Bay, from water released from the compaction of the overlying clays, by importation of a surface supply, and by some increase in transmission of ground water from the Forebay resulting from further reduction of pressure in the Pressure Area. The reduction in pressure which has occurred has resulted in a continued menace that salt water from the Bay may reach this area although fortunately this has not occurred to date.

SUMMARY OF ESTIMATES OF DRAFT, SUPPLY AND OVERDRAFT OF GROUND WATER OF NORTH SANTA CLARA VALLEY

All investigations since 1933 have found some overdraft. The amount of the estimated overdraft has been increasing in the more recent reports; this is to be expected as the draft has been increasing and there has been little change in the sources of recharge since 1952.

The estimates which have been made since Bulletin 7 was published in 1955 until the March 10, 1960, report of the Conservation District have generally concluded that from 40,000 to 67,000 acre-feet per year was needed to overcome the existing overdraft. (See Table 9.) A supply of these amounts would maintain the existing ground water elevations without replacing the present accumulated depletion. Perrott and Dunn proposed a larger rate of use of imported water in order to refill the past reduction in ground water storage.

In the report of the Conservation District of March 10, 1960, the records of ground water elevations from 1951 to 1959 were found to represent an over-all rise equivalent to an average annual increase in ground water of 23,700 acre-feet. This increase occurred under the estimated average draft for this period of 200,400 acre-feet per year with a draft in 1959 of 220,000 acre-feet. As the draft in 1959 exceeded the mean annual for the nine year period by 19,600 acre-feet, the mean supply would represent a supply in excess of the 1959 draft of 4,100 acre feet. The precipitation at San Jose for this nine year period was 101 per cent of the long time mean so that these results represent conditions with average local sources of supply obtainable with the existing works. Anderson Reservoir began storage in 1951-52 and Lexington Reservoir in 1952-53.

As different investigations have reached varying conclusions on the extent of the present overdraft and the ability to secure ground water transmission to the Pressure Area, the Review Board made its own analysis of the ground water conditions.

In the Forebay ground water fluctuations reflect the balance between supply and demand. The raising or lowering of the ground water in the Forebay or non-pressure area is an index of surplus or overdraft as it represents the balance of the elements of supply and draft. The ground water records from 1952 to 1959 represent operations when the present surface storage has been in use and the drafts have been those used to meet the demands under the recent and present conditions.

The analysis by the Review Board of the well records for the Forebay indicates that supply and demand were generally in balance for this period.

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For the Pressure Area, there was some increase in pressure from 1952 to 1959 in some areas more favorably located in relation to the Forebay or the aquifers leading from the Forebay. Restrictions on the transmissibility of water from the Forebay resulted in loss of pressure in the portions of the Pressure Area having heavier drafts.

In the report of the Conservation District of July 12, 1960, Table 1 shows a total draft for the nine municipal users in the northern portion of the Pressure Area in 1960 of 43,000 acre-feet. This report also shows an industrial draft, outside of municipal service, for the whole valley of 20,000 acre-feet in 1960. Assuming that one-half of this outside industrial draft is in the northern part of the Pressure Area, the total of this municipal and industrial use would be 53,000 acre-feet in 1960. With a use of imported water from San Francisco of 13,000 acre-feet, this estimate indicates a 1960 municipal and industrial ground water draft in this area of 40,000 acre-feet.

Conclusions of the Review Board

The preceding analysis support the conclusion that for the Forebay, except for areas around its margin, the present draft can be met by the recharge secured from the present works of the Conservation District operating with the mean annual water supply. The ground water elevation fluctuates with the annual variations in the water supply. The present total mean annual supply appears to be about equal to the demand. To date conditions in the Forebay do not appear to be critical. Present sources of supply will not replace the accumulated depletion in ground water storage that has occurred. Continuing increase in the demand will result in overdraft within a few years even with average precipitation. Additional recharge is now needed in some marginal areas of the Forebay.

As previously discussed, for the Pressure Area, the records to date indicate that the present draft exceeds the supply that can be transmitted through the available aquifers under the existing slopes. The largest overdrafts are in the vicinity of the areas of heavier municipal drafts. The present largest draft for municipal and industrial use is in the northwestern part of the Pressure Area. This is also the area of most limited adjacent recharge. To prevent continued lowering of the ground water in this area, present drafts need to be replaced with surface water service. Such replacement, leaving the use of the limited ground water supplies to agricultural and other smaller uses, should enable the ground water lowering to be checked. Eventually with the reduction of irrigation and the increase in urbanization, continued surface water service should result in full recovery of the ground water to be secured. Ground water draft could then be limited to the safe annual yields of the available supply and thus secure maximum use and economy without the continued menace of salt water intrustion.

It is the conclusion of this Board that only surface delivered sources of water supply can meet the present and future needs of the larger users of water in the northern portion of the Santa Clara Valley. As local sources of water supply are now nearly fully developed and used, this area must secure its supplemental water by importation of outside sources.

For present conditions the most desirable program for the North Santa Clara Valley appears to be to increase its spreading facilities so that the ground water may be maintained in the Forebay as the draft there increases. As there is now more surface storage than can be placed underground with present spreading facilities in years of large runoff, imported water under present conditions would be useful in the Forebay in such years only for surface water deliveries. With increasing demands, imported water will be needed for the Forebay. Percolation of such imported water will require additional percolation areas. Future conditions are discussed in other portions of this report.

For present conditions in the Pressure Area, the greatest need is to replace the present municipal pumping with surface service. There are alternate sources from which such service can be secured. Their relative costs and advantages are discussed elsewhere. The decision that needs to be made at this time by the cities in this area is that they should secure a surface source of supply as promptly as practicable without further aggravation of their ground water conditions. The present draft of these cities from their local ground water is of the order of 30,000 acre-feet per year. Such a present surface supply with provision for its increase as the demands increase should be actively sought at this time.

ADDITIONAL STORAGE OF LOCAL RUNOFF

In Table 10 the available records for the inflow and outflow for 1952 to 1959 and the estimates in Bulletin 7 for the other drainage areas have been assembled. The inflow in Table 10 represents the runoff of streams which is available for storage and percolation. The outflow includes the runoff of streams passing the lowest percolation areas and escaping to the Bay. The capacities of the existing reservoirs are also shown in Table 10. This outflow which wastes to the Bay is generally scattered and irregular so that its storage would be expensive even if storage sites were available.

The selection of the presently constructed reservoirs has been based on the available water supply and reservoir sites. Coyote Creek is the most completely controlled stream. Since its operation began in 1951, Anderson Reservoir has spilled only once (in 1958). This spill of 37,000 acre-feet was the result of 23,200 acre-feet of carryover storage from 1957 and a surplus inflow of 13,800 acre-feet. With full use of Anderson storage each year, the only uncontrollable flow during the nine years of its operation with average runoff and increased percolation capacity would have been an average of about 1,500 acre-feet per year. Coyote Creek above Edenvale is now fully regulated and additional storage capacity to regulate its tributary inflow is not justified.

Los Gatos Creek is the second largest stream tributary to the North Santa Clara Valley. Lexington Reservoir has been constructed to the capacity of its site. In addition Elsman Reservoir of the San Jose Water Works has a capacity of 6,140 acre-feet. The lack of other suitable sites restricts further storage on Los Gatos Creek and additional reservoirs have not been proposed.

The State investigated storage on San Francisquito Creek having a capacity of 11,850 acre-feet designated as the Little Francis Project. It was estimated that an average of about 3,000 acre-feet per year could be conserved at a cost of about $75.00 per acre-foot for the new water to be developed. The State did not report on other storage sites in North Santa Clara Valley.

TABLE 10

MEAN ANNUAL INFLOW AND OUTFLOW OF STREAMS IN NORTH SANTA CLARA VALLEY AND PRESENT STORAGE CAPACITIES IN ACRE-FEET

Stream	Mean Annual Inflow A	Mean Annual Outflow B	Capacity of Surface Reservoirs
Records for 1952-59			
Permanente Creek	4,300	3,200	
Stevens Creek	12,800	6,800	3,966
Calabazas Creek	2,300	1,800	
Campbell Creek	8,600	6,400	
San Tomas Creek	3,800	3,000	(1)
Los Gatos Creek	33,700	13,400	22,225
(Los Alamitos Creek			11,185 (2)
(Guadalupe Creek	38,200	13,800	3,460
(Fisher Creek			(3)
(Coyote Creek	50,700	7,300	99,560
Penitencia Creek	5,500	3,600	
Total	159,900	59,300	140,396
Other Estimates from Bulletin 7			
San Francisquito Creek	14,300	12,200	
Silver and Dry Creeks	3,600	700	
Total measured	177,800	72,200	
Unmeasured	25,200	8,200	
Total	203,000	80,400	

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(1) Lexington and Vasona Reservoirs - Elsman Res. not included.
(2) Almaden and Calero Reservoirs.
(3) Anderson and Coyote Reservoirs.

A= Runoff of streams available for storage and percolation.

B= Runoff of streams passing lowest percolation areas and escaping to Bay.

These results indicate that only limited opportunities remain for securing increased use of local runoff by the construction of additional surface reservoirs. Some increased use of present surface reservoirs may be obtainable by increased percolation capacity so that water in surface storage will not be carried over and full reservoir capacity may be available each year.

Increased storage of local water supply should be constructed wherever economical projects may exist but such developments will not be sufficient in size to affect the over-all water problems of the North Santa Clara Valley.

UNUSED LOCAL SOURCES

The term "local sources" as here used includes runoff naturally tributary to North Santa Clara Valley and proposed projects for diverting water from adjacent drainage areas. These adjacent drainage areas include the Uvas and Llagas in southern Santa Clara County and Soquel and Zayante Creeks in Santa Cruz County. In other portions of this report the term "imported water" has been used to describe projects importing water from distant sources.

In his report, in response to the instructions of the Board of the Conservation District of January 13, 1959, Mr. Roll proposed diversion of the flow of Coyote Creek using the present storage in Coyote and Anderson Reservoirs. This report proposed that transmission facilities should be extended to deliver such water to west side areas as far as Palo Alto. Such works were estimated to provide an average annual supply for municipal use by surface delivery of 24,350 acre-feet (p. 19) and an equal supply for percolation to the ground water (p. 20), a total of 48,700 acre-feet.

These estimates have been superseded by the Cross-Valley Project described in the Conservation District's report of July 12, 1960. This later report has been discussed elsewhere in this report. It would convey water from Anderson Reservoir to Los Gatos Creek.

Northern Valley Project

In Bulletin 7 the State described a plan designated as The Northern Valley Project, under which water would be pumped from the proposed Coyote Valley Well Field for distribution to the northern portion of the Valley. Based on a 3-1/2 per cent interest rate and costs prevailing in the Fall of 1954, the capital cost was estimated to be $2,230,000 and the annual cost $152,000. It was estimated that a mean annual supply of 8,900 acre-feet of new water could be secured at an average cost of about $17 per acre-foot, exclusive of pumping costs.

Experience since 1954 has indicated that Coyote Creek is now practically fully regulated by Anderson and Coyote Reservoirs. The plan proposed in Bulletin 7 would provide additional ground water storage capacity in the Coyote Well Field which would be useful only during periods of greater sustained runoff than have occurred in the period of average runoff from 1950 to 1960. The Northern Valley Project described in Bulletin 7 represents a different distribution within the Valley of the water now conserved by surface storage rather than the development of an additional supply. The pumping from the Coyote Well Field works were estimated to provide an average annual supply for municipal use by surface delivery of 24,350 acre-feet (p. 19) and an equal supply for percolation to the ground water (p. 20), a total of 48,700 acre-feet.

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Other Local Reservoirs

Six other reservoirs on the remaining uncontrolled streams within the North Santa Clara Valley have been investigated by the Conservation District. The combined average annual yield was estimated to be 9,000 acre-feet. These six sites were on Penitencia, Guadalupe, Silver, Calabazas, Permanente, and San Tomas Creek. None of these sites have been included in present plans for local development. They would be relatively expensive for the water they would make available.

A report made for the Flood Control District in February 1957 on storage on Matadero Creek near Palo Alto found a safe yield of 240 acre-feet per year could be secured with a reservoir capacity of 3,850 acre-feet. The annual cost per acre-foot of yield was estimated to be $472.

Projects on Adjacent Streams

Engineering studies by the Conservation District of storage on the Uvas and Llagas Creeks estimated that an average annual yield of 36,000 acre-feet could be secured from a 100,000 acre-foot reservoir. This yield would be secured from the runoff in excess of the ultimate needs of the South Santa Clara Valley Water Conservation District. It was estimated that about 16,000 acre-feet per year of this total yield might be obtained for use in North Santa Clara Valley from such a project. Diversion of such water to North Santa Clara Valley would involve agreements with the South Santa Clara Valley

Water Conservation District. Plans for its construction are not under active consideration at the present time.

Investigations have indicated that the controllable runoff of Soquel Creek in Santa Cruz County exceeds the local needs and a joint project between Santa Cruz and Santa Clara Counties could produce water for use in Santa Clara County. The amount of such a supply that might be secured for use in North Santa Clara Valley has not been determined.

In Bulletin 7 the State described a proposed storage project on Zayante Creek in Santa Cruz County. The water stored would be pumped to Los Gatos Creek for use in the North Santa Clara Valley. The reservoir would have a capacity of 6,900 acre-feet and a mean annual yield of 4,000 acre-feet. The maximum pumping lift would be 395 feet and the conduit length 6.4 miles. The construction cost, based on prices in the fall of 1954, was estimated to be $2,657,200. The annual costs based on a 3-1/2 per cent interest rate was estimated to be $179,400 giving an annual cost per acre-foot of yield of about $45.00.

Summary of Local and Adjacent Projects

The preceding discussion supports the conclusion that opportunities for further conservation of local sources of supply are limited and expensive. No such projects, either singly or as a group, can provide sufficient water to meet the present or future needs of the North Santa Clara Valley. At best they may furnish some water which could be used to reduce the amount of the imported supply that is needed. If and when conditions may develop under which any local project can supply water at less cost than the alternate imported source it can be built.

The opportunities for diversion from adjacent drainage areas are generally similar to those for local streams. At some time conditions may be such that the South and North Santa Clara Valleys can work out a joint project to their mutual advantage on Llagas and Uvas Creeks. If this occurs the water that may become available for use in North Santa Clara Valley may be used to reduce the amount of imported water that would otherwise be needed.

Local projects to take water to other parts of the valley than the areas to which it is naturally tributary may be useful in equalizing the supply and improving conditions in the areas to which it is taken. Such projects, however, do not represent material increases in the extent of the total available supply.

From the review of the remaining opportunities for further development of its local and adjacent water resources, the Review Board has concluded that the present and expected future water needs of North Santa Clara Valley can only be met by the importation of water from some other distant source.

CROSS VALLEY PROJECT

The Conservation District's report of July 12, 1960, on "Additional Conservation and Distribution Facilities" includes a Cross-Valley Project consisting of a conduit from Anderson Reservoir to Calero Reservoir and on to Los Gatos Creek for the purpose of distributing the present stored water supply more widely in the Forebay and to be used as a part of the system that will be needed to distribute imported water for percolation in the Forebay.

This project includes the acquirement of spreading areas having an estimated percolation capacity of 11,000 acre-feet per month. The conduit would have a diameter of 72 inches and a capacity of 185 second-feet. The seasonal capacity is estimated as 71,500 acre-feet. The total length of conduit would be about 103,000 feet. The estimated construction cost is $9,871,900. Based on 25 year bonds at 4-1/2 per cent interest, the estimated annual cost during the life of the bonds was $703,200. For an average annual use of 71,500 acre-feet, the cost per acre-foot would be $9.75.

While the Review Board has not made a detailed study of these estimated costs, they appear to be carefully worked out and to furnish an adequate basis on which to evaluate this project. The Board has used 50 year bonds at four per cent interest in order that the results may be on a similar basis to that used for other projects for imported water. On this basis the annual cost per acre-foot when used for 71,500 acre-feet would be $7.00.

Until imported water has become available at a point on Coyote Creek from which it can be delivered into such a Cross-Valley conduit, the conduit's usefulness will be limited to a different distribution of the water now being used from Anderson and Coyote Reservoirs. As the runoff of Coyote Creek is now almost completely regulated, only limited amounts of additional total percolation would be obtainable.

When imported water may be available at Coyote Creek, such a Cross-Valley Conduit will be an essential part of its distribution to areas where it can be used to recharge the ground water in the Forebay.

The project proposed in the July 12, 1960, report starts at a normal water elevation of 575 feet in Anderson Reservoir and conveys water under pressure over the Santa Teresa Hills enroute to Calero Reservoir. No pumping lift is required for the conveyance of water from Anderson to the terminus of the conduit on Los Gatos Creek at an elevation of 350 feet. Present plans for importing water from either the South Bay Aqueduct or Pacheco Pass Routes would deliver water at Coyote Creek at an elevation of about 350 feet. A pumping lift of about 210 feet would be required to convey such imported water to Calero Reservoir and on to the elevation of the spreading areas proposed to be used.

It is the conclusion of the Review Board that such a Cross-Valley Project is an essential part of the distribution of imported water to meet the needs of the southwestern portion of the Forebay. While there will be only a limited amount of additional water made available by its construction in advance of the availability of imported water, it can be used to distribute existing local sources more widely. The time of its construction is optional. Prior to the availability of imported water, its costs for the amounts of new water it would make available would be relatively high. When used to convey 71,500 acre-feet per year, using 50 year bonds at four per cent the annual cost would be about $7.00 per acre-foot. Such costs should be added to the other costs of imported water to be percolated into the Forebay in estimates of the total cost of imported water.

MORGAN HILL PROJECT

In the Conservation District's report of July 12, 1960, on "Additional Conservation and Distribution Facilities" a Morgan Hill Project is proposed to convey water from Anderson Reservoir southward to supply a surface distribution system to serve an area northeast of Morgan Hill.

A main pipe line varying in diameter from 39 to 27 inches with a total length of 21,000 feet is proposed to serve an area of 4,500 acres. The estimated cost is $632,300. Under the policies of the Conservation District, the District will construct such main lines for surface service into areas lacking percolation areas provided that the users to be served meet the costs of the required laterals, that there is sufficient area to be served to make the project feasible, and that the users assume any costs for pumping that may be involved.

This report proposes that the Conservation District vote bonds for this project but that no bonds be sold until a local improvement district containing at least 2,000 acres has been formed to assume the local costs.

This project does not provide water in addition to that now available from the present sources of supply. It represents distribution of a part of the present supply into a local area of the District. Water which may be conveyed to this area from Anderson Reservoir would represent a change in its present use for percolation in other parts of the District. Necessary hold-over storage to meet reliable direct water service would decrease the effectiveness of Anderson Reservoir in conserving water.

This project, in the opinion of the Review Board, represents a matter for internal decision by the Conservation District. As it does not affect the acquirement of additional local or imported water it is outside of the scope of the work of the Review Board.

BERRYESSA PERCOLATION PROJECT

The Conservation District's report of July 12, 1960, on "Additional Conservation and Distribution Facilities" includes a project to pump from lower Coyote Creek to spreading grounds along Penitencia Creek. A similar project to pump reclaimed sewage has been discussed previously in this report.

The construction of a pumping plant at Standish Dam on Coyote Creek is proposed, to use its flow until works may be completed which may supply a usable sewage effluent. This effluent would be pumped to the Coyote Creek pumping plant and be conveyed in the conduits now planned.

The total estimated cost is $1,842,900. The annual cost based on 25 year bonds at 4-1/2 per cent interest with the project used to divert 21,000 acre-feet per year would be $10.00 per acre-foot for this repayment period. Based on 50 year four per cent bonds, similarly to the basis used for imported water projects, the estimated cost during the 50 year period would be about $8.00 per acre-foot for the 21,000 acre-feet per year proposed to be used.

This project would require sufficient spreading area to percolate this amount. The present percolation areas along Penitencia Creek have shown a good rate of percolation. With an increase in the present spreading area the proposed amount of percolation may be obtainable. At present the mean annual outflow of Coyote Creek leaving the Forebay is estimated to be 7,300 acre-feet (Table 10). This occurs irregularly and would only be partly divertable. The amount of sewage exceeds 30,000 acre-feet per year distributed throughout the year. This exceeds the proposed capacity of this project.

The Penitencia Creek percolation areas are located in the Forebay above the Pressure Area along the northeastern portion of North Santa Clara Valley. The local ground water has been lowering in this area. The proposed project would replenish the ground water in an area where recharge is needed. Recharge from percolation further to the south does not reach this area in amounts sufficient to meet the present draft. Whether water for percolation may be secured from the presently proposed Berryessa Pumping Project or from imported water,use should be made of the percolation capacity on Penitencia Creek to maintain the ground water and to replace the depletion that has occurred in this portion of North Santa Clara Valley.

This project would provide percolation water at the Penitencia spreading area at costs well below those proposed for any imported supplies provided the sewage is of proper quality and is treated so as to be usable with the costs of such treatmentcharged to sewage disposal rather than to ground water recharge.

If built to use 21,000 acre-feet per year this project will reduce the demand for imported water by an equal amount. If water is imported by the South Bay Route and conveyed to Coyote Creek for recharge of the southern portion of the Forebay, the conduit for such conveyance will cross the percolating area on Penitencia Creek. If the amount of reclaimed sewage that may be usable exceeds 21,000 acre-feet per year, the remainder could be placed in such a conduit to Coyote Creek and used in other portions of the Valley.

Adequate treatment of the sewage to produce water usable for such a project is now being actively planned. Such conservation is highly desirable if feasible, but its costs must be compared with the incremental costs of an equivalent supply.

The Review Board has based its estimates and comparisons on projects to supply imported water on meeting the full present demand for imported water. When adequately treated sewage may become available, it can be included in the water plans of the area and serve within its limitations to meet its increasing needs.

GENERAL CONDITIONS RELATING TO THE USE OF IMPORTED WATER

As discussed in preceding portions of this report, it has been concluded that the water needed to meet the present and future demands of North Santa Clara County is not obtainable from additional development of local or adjacent sources. To meet these demands water will need to be imported from some more distant source. The sources for such an imported supply now being considered are the proposed State's Feather River Project, the City of San Francisco's Hetch Hetchy supply and the U.S. Bureau of Reclamation's Central Valley Project. There are also alternate routes by which water may be imported.

Comparisons of alternate sources of imported water require definitions of the amounts of water that can be supplied, the points of delivery and the costs reduced as nearly as may be practicable to a common basis. Part of the imported water can be used for surface delivery but all present plans recognize that ground water recharge should be used for those areas where it can be more economically effective. Delivery for such recharge must be made to areas where percolation can be secured. With the draft on the Pressure Area already exceeding the transmission capacity from the Forebay, the present demands in the Pressure Area cannot be met by additional recharge in the Forebay alone. At least some surface delivery to areas of need in the Pressure Area is required.

In preceding portions of this report it has been concluded that imported water will be needed both for surface service in the northern part of the Pressure Area and for percolation to the ground water in the Forebay. Any project for importing water must include both the constructed works required to bring the water to the Valley and also to convey and distribute it to the areas where it will be used. It is necessary to include the costs of such local distribution to the customers of actual use in any comparison of sources and routes for imported water.

All proposed sources of imported water can supply the amounts of the present water demands for their use. All meet the standards for mineral quality. Water from the Delta will require treatment if it is used directly for municipal purposes; all sources are suitable for ground water percolation. All sources can be used for any purpose anywhere in North Santa Clara Valley except Hetch Hetchy water which is limited to public agencies for municipal and industrial uses in the area in which San Francisco has stated it is prepared to serve.

The rapidly increasing density of urban development with its large increase in land values now makes the costs of right of way relatively high. Where grade conditions would permit, open canals could and were used in earlier construction. At present conveyance into the areas of larger need will have to be by closed conduits both to reduce the extent of land required for rights of way and to avoid safety hazards. This increases the cost of conveyance. With irrigation being replaced by urbanization, surface distribution for irrigation use in general has now become too costly for it to be built to serve irrigation for the time remaining before it is replaced by municipal use.

Pipe distribution systems can and should be used for municipal and industrial purposes. Some irrigation use might be made temporarily of a distribution system constructed for an expanding municipal use but primarily the irrigation in this Valley will continue to use wells drawing on the underlying ground water. As previously discussed, this can be done by relieving the total draft on the ground water in the Pressure Area by replacing the present municipal ground water draft with surface service and using the available ground water for irrigation.

The present municipal use in the entire Valley is now supplied from wells except for a small amount of surface storage of the San Jose Water Works and water purchased from the City of San Francisco's Hetch Hetchy system. The cities in the northern portion of the area are now using their underlying ground water to the limit of its capacity. Their present ground water draft should be replaced by surface delivery of imported water and their future increases in demand will need to be met by similar service.

The municipal draft in the Forebay Area and for some of the adjacent Pressure Area can be met by draft on ground water. The present draft is now met from this source, generally without overdraft. Additional draft in this area can be met similarly provided areas having sufficient percolation capacity, properly distributed, are available and used to enable adequate recharge with imported water to be made.

The present distribution system of the San Jose Water Works has been developed by the use of wells distributed over its service area. Its present system has a capacity suitable to such sources of supply. To use surface sources of supply delivered at any point in its system would require extensive large transmission mains feeding into the present distribution system.

San Jose is in both the Forebay and the Pressure Areas. The larger part of its area and use is in the Forebay or the adjacent upper portions of the Pressure Area. The extension of the city to the north, in the main, is in the Pressure Area and is subject to its problems of transmission of its ground water from the Forebay. Over-all it is considered that San Jose can and will continue to be supplied from its underlying ground water until its use may exceed the recharge capacity of the Forebay. Serious overdraft is not expected to occur within the time for which the works proposed for present construction will meet the demand.

The City of Santa Clara overlies the Pressure Area. It is generally within the upper portions of this area and can probably be supplied from its underlying ground water if the Forebay is recharged with imported water. It is assumed that Santa Clara will continue to use wells as its source of supply until this source may prove to be inadequate. Present plans should be based on trying to meet its draft by recharge of the Forebay with imported water.

It is also concluded that Campbell and the communities to the south and west will continue to be served from their local wells and the surface supplies obtainable from the present surface storage in this area.

The indicated amounts of ground water movement from the Forebay to the Pressure area previously derived in Tables 7 and 8 are sufficient to meet much of the ground water draft in the upper portion of the Pressure Area in which San Jose and Santa Clara now have wells. While a change by these cities to surface service using an imported supply would aid in the recovery of their underlying ground water it is considered that such a change is optional rather than a necessity.

This leaves the cities in the northern portion of the Valley as the ones definitely requiring surface service. Replacement of their present ground water draft by the use of some imported supply will result in an improvement of the quality of the supply as well as relieve the overdraft on the ground water. As their ground water supply is now overdrawn and the present overdraft will not be met by additional recharge in the Forebay, the future increases in use for these cities will need to be supplied by surface delivery of imported water.

Much of the expected increase in use by the cities in the northern part of the valley will result from their expansion into areas now irrigated and their replacement of present draft for irrigation. Such an increase in municipal use also represents a water demand that can best be met by surface delivery of an imported supply and thus result in further reduction of the present ground water draft.

The Conservation District's report of July 12, 1960, includes the present and the expected future use of water by the municipalities in the North Santa Clara Valley. For present conditions such total use is about 43,000 acre-feet per year. About 13,000 acre-feet per year was purchased from the City of San Francisco in 1959-60. This report estimates that the use by these municipalities in 1980 will be 92,000 acre-feet and in 2000 will be 122,000 acre-feet. The present ground water draft of these cities is about 30,000 acre-feet per year. Replacing this draft by an imported surface supply would remove the present ground water overdraft in the portion of the Pressure Area from which they pump. This report represents an estimate that the use by these cities will more than double by 1980, representing an increase in use of about 50,000 acre-feet, and that an additional 30,000 acre-feet will be needed by 2000.

Restoration of the ground water pressure elevations in the Pressure Area, so that compaction will be checked and ground water movement from beneath San Francisco Bay will be retarded, can be accomplished most readily by a replacement of present overdraft from the Pressure Area with surface water service and an increased recharge in the Forebay to create more rapid pressure transmission to the areas now having ground water pressures below sea level.

If the municipalities in the northern part of the Pressure Area replace their present ground water draft with an imported surface supply, an additional imported supply for use in the Forebay of 20,000 acre-feet is now needed and 45,000 to 50,000 acre-feet per year is desirable in order that the present depletion may be more rapidly replaced. Such additional supplies can only be used by percolation in the Forebay.

The capacity of the present spreading works using Coyote Creek runoff is now fully used. Each year since Anderson Reservoir has been in use, it has had water in storage at the end of the year which could not be percolated in the preceding season until 1960. In 1960 Anderson was emptied with about 15,000 acre-feet of storage carried over in Coyote Reservoir.

Importation of additional water for ground water recharge will require additional facilities for its percolation. This has been recognized by the Conservation District and provision has been made for the acquirement of additional spreading areas.

In the report of July 12, 1960, the locations of spreading areas having an estimated total percolation capacity of 71,500 acre-feet per year are shown on Plate II. These areas would be supplied by the Cross Valley Project proposed in this report. Such areas are additional to those now in use. Funds for the cost of acquirement of these areas have been provided. It is proposed that the Cross Valley project will be financed and built by the Conservation District.

These additional spreading areas are located mainly from Alamitos Creek to Saratoga Creek and would recharge the ground water in the southwest portion of the valley where it could move into the more heavily pumped portions of the Forebay. Sufficient of these spreading areas should be acquired and be ready to be used to meet present needs as soon as an imported supply may become available. Recharge of the Forebay from such spreading areas will benefit adjacent portions of the Pressure Area but would not be expected to reach the areas of heavy present ground water draft in the northwestern part of the area.

To meet the demands and the location of the required spreading areas, any imported supply will need to be delivered to Coyote Creek at an elevation which will enable it to be diverted into a distribution system extending to the west side of the valley. The elevation of the proposed delivery on Coyote Creek is about 350 feet. This is a common and comparable point of delivery for water which may be imported by either the South Bay Aqueduct or the Pacheco Pass Route. Imported water would be pumped at this point for delivery into Calero Reservoir and distributed by gravity therefrom.

The comparisons which have been made of different proposed sources of supply and conveyance routes are based on meeting the service requirements which have been discussed. To meet present conditions in North Santa Clara Valley any project for importing water must provide for surface service to the northern portion of the Pressure Area and for delivery where it can be percolated in the Forebay. The costs of local works for such distribution are an essential part of the total costs for any imported supply and have been included in the cost comparisons which have been made.

The cost per acre-foot of water used will vary with the amount used. For small rates of use the fixed charges represent a high cost per acre-foot.

To enable the different proposed projects to be compared, costs have been derived for what represent a minimum, a medium and a large use of the initial construction which is proposed. The amounts of these uses are based on the conclusions previously derived in this report.

Any project importing water to North Santa Clara Valley should have a minimum initial use of 30, 000 acre-feet even if it only serves the present municipal demand in the northern part of the Valley. An additional 30, 000 acre-foot for percolation in the Forebay should be used to replace past depletion there. Initial construction should have additional capacity to meet the expected increase in demand. The State's plans for the first stage of the South Bay Aqueduct are based on providing 88, 000 acre-feet per year for Santa Clara County. As this is a proper capacity for perhaps 20 years use, it has been used for other proposed projects in comparisons with the South Bay Aqueduct.

PLANS FOR THE STATE'S SOUTH BAY AQUEDUCT

Present plans for the State's South Bay Aqueduct include delivery of water into the proposed Airpoint Reservoir for distribution from the reservoir by local agencies. This aqueduct, as formerly proposed, extended to San Benito County. Its present physical plans are the result of the conclusions recently reached regarding the delivery to the areas now expected to be purchasers of water. There are no restricting limits in its authorization which prevent extending the South Bay Aqueduct beyond Airpoint if this should become desirable. The results of the recent investigations of the delivery of water to the southern portion of the area formerly expected to be served by the South Bay Aqueduct through a tunnel under Pacheco Pass, have caused present planning to be based on limiting South Bay Aqueduct service in Santa Clara County to its northern valley.

The State requires repayment for all costs allocated to the South Bay Aqueduct from those contracting for the water which it will deliver. Joint costs for other parts of the Feather River Project will be allocated between the different areas of use. The users from the South Bay Aqueduct will share in project costs above the head of the Aqueduct with the other users of the project. It is proposed that an initial general Delta Water Rate of $3.50 per acre-foot should be charged to all users of water from the Delta to cover costs for delivery to the Delta. Such charges are later to be adjusted to the actual costs to the State. The South Bay Aqueduct will participate in the costs of the pumping plant and canal to its diversion from the main aqueduct in the San Joaquin Valley. All costs from this diversion will be charged to the South Bay Aqueduct.

Costs of the South Bay Aqueduct will be allocated among its areas of use on the same basis as the main project works. Each service area will participate in the costs of jointly used works and meet all of the costs of separate works for its own area. On this basis the North Santa Clara Valley, as the last area of service, will share in the costs of works above the points of delivery to Contra Costa and Alameda County areas and will meet all costs for construction beyond the last point of delivery to Alameda County. The terminal delivery to Alameda County, as now proposed, is below the outlet of the Mission Tunnel near Mission San Jose. All costs for storage at Airpoint

Reservoir will be chargeable to Santa Clara Valley.

The State now proposes a multiple part charge for water, as set forth in its contract of November 4, 1960, with the Metropolitan Water District of Southern California. These charges include the following:-

1. The Delta Water Rate.

2. Transportation charges composed of:
    - A. Interest and retirement of capital costs;
    - B. Replacement and minimum operation, maintenance, power and replacement cost;
    - C. Operation and maintenance, power and replacement which vary with quality of water delivery.

Item 2-C has been expressed in terms of a price per acre-foot of delivery.

This form of rate results in the total cost per acre-foot in any year varying with the amount of water used. On completion of construction the capital charge, replacement and minimum operation charges would have to be met in full although, in the early years of operation, the works would be used only to partial capacity. This makes the actual total cost per acre-foot received higher in the early years of operation than that in later years when more water will be used.

In general statements which the State has issued, it has listed both the fixed annual charge and the meter price per acre-foot of delivered water. The total annual cost per acre-foot stated has been based on the fixed charge divided by the expected mean annual amounts of water used during the bond repayment period. This procedure, while correct for the average costs, omits the higher costs during early years of smaller use and the lower cost under the later full use.

As a result of the position taken by San Francisco regarding service from a state project within what it regards as its service area, the State has made available more information relating to the service from the South Bay Aqueduct in this competing area than is now available for its other service in Santa Clara County. Use is made of this material in the following discussion. The conditions relating to service by purchase of water from San Francisco are discussed later.

The most recently released estimated costs for water to be delivered by the State at the outlet of Airpoint Reservoir are contained in "Information and Basic Data Concerning the Construction, Cost Allocation and Financing of the South Bay Aqueduct Project" dated March 11, 1960. The same estimated costs per acre-foot delivered are used in the release of the Department of Water Resources dated June 23, 1960.

The project on which these reports are based is the South Bay Aqueduct of the Feather River Project using Oroville storage, Delta Cross-channel and conservations works and the State's proposed pumping plant from the Delta. The cost of water would include the State's proposed initial Delta rate of $3.50 per acre-foot.

These costs are for an aqueduct capacity of 210,000 acre-feet per year. Of this initial capacity 88,000 acre-feet per year was allocated to Santa Clara County. All of this allotment was considered to be for urban use. The ultimate capacity of the whole Aqueduct is to be 400, 000 acre-feet per year of which 179, 000 acre-feet was allocated to Santa Clara County. The initial use by Santa Clara County on completion of the aqueduct proposed by the State for 1964, was 66, 000 acre-feet per year.

The diversion capacity now planned is 300 second feet. This would be reduced to 179 second feet below the outlet of the Mission Pass Tunnel where all of the remaining flow would be for Santa Clara County. To deliver 210, 000 acre-feet per year with a capacity of 300 second feet represents a use to capacity for 96 per cent of the time and 88, 000 acre-feet with a capacity of 179 second feet is equivalent to full delivery for 43 per cent of the time. For the upper portion of the Aqueduct to Del Valle Reservoir continuous operation is planned. From Del Valle Reservoir to Mission Pass Tunnel a capacity of 295 second feet is planned for the delivery to Hayward, the Alameda County Water District and Santa Clara County of 146, 000 acre-feet per year, equivalent to full capacity operation for 68 per cent of the time.

The present estimated construction costs allocated to Santa Clara County are $22, 264, 000 of the total of $40, 572, 000 based on the proportionate use of facilities for the entire system. Of this total $8, 750, 000 would be for costs from the Alameda-Hayward Turnout to and including Airpoint Reservoir which would be used entirely by Santa Clara County.

For financing with four per cent 50-year bonds as proposed by the State the annual capital charge would be $1, 036, 000. The State also estimates that the annual operation and maintenance cost will be $10. 05 per acre-foot. Using these results, plus the Delta rate of $3. 50 per acre-foot, the annual total costs per acre foot for different amounts of use would be about as follows: -

	Cost per acre-foot
For use of 30,000 acre-feet per year	$48.10
60,000 " " " "	30.80
88,000 " " " "	24.80

In a statement dated March 14, 1960, the State agreed to delay construction of the South Bay Aqueduct beyond Patterson Reservoir to allow time for the areas involved to determine whether they desire to secure water from the State or from San Francisco. The statement issued June 23, 1960, included the estimated costs and the prices at which the State is prepared to contract for delivery of water from the South Bay Aqueduct when extended to Airpoint. The general principles on which service and prices for water from the Feather River would be based were stated in a release of January 21, 1960, and were applied to the South Bay Aqueduct.

In its statement of June 23, 1960, the State based the total cost of water from the South Bay Aqueduct to cities in northwestern Santa Clara Valley on its own estimates of the costs of construction and operation of the Aqueduct, to and including Airpoint Reservoir, plus local estimates of the cost of treating and distributing water from Airpoint to these cities. These prices are $25.66 per acre-foot for costs by the State to Airpoint, $14.00 per acre-foot for conveyance from Airpoint Reservoir and $11.00 per acre-foot for treatment, a total of $50.66. These local costs were included in order that the total cost would be directly comparable with the prices which San Francisco may make for equivalent service from its Hetch Hetchy supply. These results would be the average cost during the life of the bonds for the amounts of water which the State estimated these cities would purchase.

The costs of water to contracting users from the South Bay Aqueduct shown in the State's letter of June 23, 1960, are based on its then estimates of the construction and operating costs of the Aqueduct. They are not an offer to contract for this service at these prices during the life of the contract. The actual charges for water will be based on the actual costs when the Aqueduct has been constructed. If the actual costs are less than those now estimated the charges for water will be less than those now stated; if the actual costs exceed present estimates the charges for water will be increased. If during the operation of the project the operation costs increase, the contracting user will have to meet such increased costs.

The estimated cost of water at Airpoint Reservoir as given in the State's release of June 23, 1960, is based on the delivery from the South Bay Aqueduct at Airpoint. This is a modified project from the present initial stage of the Aqueduct, now under construction, which will purchase Bureau of Reclamation water in the Delta Mendota Canal and pump it into the Livermore Valley with works which will be partially replaced when the Feather River Project is constructed. No delivery to Santa Clara County is included in this initial construction.

CONDUIT AIRPOINT TO COYOTE CREEK

Service from a South Bay Aqueduct to Airpoint and delivery to cities in the northern part of North Santa Clara Valley by locally constructed works will not meet either the present or future needs of the entire valley. It will be necessary to provide imported water for percolation into the Forebay in the southwestern part of the Valley. If a South Bay Aqueduct supply is used for such service a conduit from Airpoint to Coyote Creek for delivery into a Cross Valley conduit to the west will be required.

There are no available estimates for a pipe conduit from Airpoint to Coyote Creek of the capacity required for such a delivery. The published estimates of the State for the South Bay Aqueduct to San Benito County do not include the cost of conveyance between Airpoint and Evergreen as a separate item. The office records of the State include an estimate of $8,255,100 (1955 prices) for the 65,600 feet of such a conduit. This is equivalent to an average cost of $124 per foot for a capacity of 230 second feet. An 84 inch diameter pipe was planned in these estimates. The State in Bulletin 7 describes a conduit from Airpoint to Evergreen and from Evergreen around the south and west sides of the valley to Felt Lake near Palo Alto but does not state its estimated cost or capacity.

Mr. Mark Thomas, in January 1959, made a preliminary estimate of a canal from Airpoint to Coyote Creek for the Authority. This canal would have a capacity of 270 second feet and 160,000 acre feet per year if operated for 300 days. Such a concrete lined canal would have a length of 110,000 feet and an estimated cost of $3,000,000. Mr. Thomas' estimate recognized that pipe would need to be used in residential areas and that additional pipe would be needed if construction should be delayed. For 4,000 feet of 72 inch pipe in the Alum Rock area an estimated cost of $100 per foot was used exclusive of engineering and contingencies of 25 per cent. An all pipe conduit would have a shorter length of perhaps 20 per cent over a canal following the contours. On this rough basis, a 72 inch pipe having a length of 88, 000 feet and an over-call cost of $125 per foot might have a total cost of $11, 000. 00.

The presently proposed South Bay Aqueduct has an elevation of 360 feet at the creek below the Airpoint Reservoir. The elevation of high water in Airpoint is 503 feet for 5, 000 acre-feet storage capacity with only limited storage capacity below 430 feet. The elevation of the grade line of the proposed conduit from Coyote Creek to Calero Reservoir at Coyote Creek is about 350 feet. This allows a friction grade of 80 feet for about 88, 000 feet of pipe under minimum storage at Airpoint and 153 feet when Airpoint Reservoir is full. Such a pipe would have a capacity varying from about 125 second feet with this minimum grade to 200 second feet when Airpoint was full. Delivery of 100, 000 acre-feet per year could be made with such a line. This exceeds the expected demand for the next 20 years and may exceed the spreading capacity which is planned. Further engineering studies may result in the selection of a smaller diameter pipe for the initial construction of such a line.

Mr. Thomas' proposed canal from Airpoint has an inlet elevation of about 325 feet and would deliver its discharge at Metcalfe Road on Coyote Creek at an elevation of about 275 feet. This is about 75 feet lower than water could be delivered there by a pipe line using the elevation of storage in Airpoint Reservoir. Water delivered at Coyote Creek at elevation 275 would require a pumping lift of about 285 feet to enable it to be pumped over the Santa Teresa Hills to Calero Reservoir.

In the earlier study reported on page 17 of the 1955 Feather River

Project report it is stated that the cost of the lateral around the west side of the Santa Clara Valley was not included in the cost of the Feather River Project. Such proposed lateral "would start at a turnout on the main conduit about one mile northwest of the Evergreen Dam at elevation 450 feet. It would traverse the Santa Clara Valley, passing about seven miles south of San Jose, and continue westerly to the vicinity of Saratoga and thence along the base of the foothills in a northwesterly direction, passing near Monte Vista and Los Altos to a terminus at Felt Reservoir at a maximum water surface elevation of 380 feet. The total length of conduit would be approximately 30 miles." It was planned to deliver 240,000 acre-feet per year to water deficient areas in Alameda, Santa Clara, and San Benito Counties.

In the 1955 report on "Financing and Constructing the Feather River Project", Sheet 2 of Plate 6 shows a pipe conduit extending from the proposed Evergreen Reservoir around the Valley to Mountain View. Its total length was 30 miles. The profile on Sheet 2 shows it starting and ending at about elevation 400 with its grade line varying generally between elevations of 200 and 300 feet. This line would cross Coyote Creek near Edenvale and Los Alamitos Creek about four miles below Calero Reservoir. This same sheet shows Airpoint Reservoir at mile 40.8 and Evergreen Reservoir at mile 55 giving a length of conduit of 14.2 miles or 75,000 feet between these points.

The Progress Design Report on South Bay Aqueduct of June 27, 1958, covers the aqueduct to and including Airpoint Reservoir only. On page 9 the conduit has a diameter of 78 inches from Mission Tunnel to the Alameda County takeout and 72 inches thereafter. Its total length is 9.36 miles. On page 43 its estimated cost is given as $4,149,300 equal to an average cost of $84 per foot. On Plate 2, Sheet 4, the low point in the conduit grade below Airpoint Reservoir is 310 feet with the elevation of the conduit at the Santa Clara County line 468.7 feet. The grade of the 72 inch conduit is .00156 (8.2 feet per mile) and its capacity 189 second feet. The high water elevation in Airpoint Reservoir for a capacity of 5,000 acre-feet is 528 feet.

Based on these items of information, for the purposes of this report it has been concluded that in comparisons of the cost of imported water delivered at elevation 350 on Coyote Creek, about 90,000 feet of 72 inch pipe will be needed from Airpoint Reservoir to this diversion at a probable cost of $9,000,000. Delivery from the South Bay Aqueduct and Airpoint Reservoir will be at an elevation which will enable gravity flow delivery to be secured to meet present needs and the expected demands for some time. Later when ultimate demands are approached the discharge can be increased by booster pumping or by a second pipe line.

The annual cost of such a pipe line financed with 50-year bonds and four per cent interest on the basis just discussed would be as follows: -

Interest and amortization of bonds $9,000,000 at 4.65 per cent	$418,000
Operation and Maintenance costs at 0.38 per cent	34,000
Total Annual Cost	$452,000

The costs per acre-foot for different amounts of use would be as follows:

For use of 30,000 acre-feet per year	$ 15.00
60,000 " " " "	7.50
88,000 " " " "	5.00

These costs would be added to the cost of water at Airpoint to give costs for delivery at Coyote Creek.

CROSS VALLEY CONDUIT FROM COYOTE CREEK

If the entire supply of imported water should be secured from a Pacheco Pass Route delivered at Coyote Creek, a conduit extending around the west side of the Valley as far as Palo Alto would be required. If water is imported by a South Bay Aqueduct the needs of the cities in the northern part of the Valley could and probably would be met by a pipe line across the northern portion of the Valley. If these northern cities secure their imported water supply from San Francisco a conduit from Coyote Creek to the west side will be needed to deliver water to the spreading grounds for percolation to the Forebay. Estimates of the cost of conveyance from Coyote Creek to Los Gatos Creek and from Los Gatos Creek to Palo Alto are needed for comparisons of these alternate methods of delivery. Dependence on a Pacheco Pass route alone and conveyance around the west side of the Valley would not meet the needs of the northeast part of the Valley near Milpitas unless the present canal to Evergreen is extended to this area or sewage treatment should enable the San Jose sewage to be used for percolation there.

The Conservation District's report of July 12, 1960, includes a Cross Valley Project to convey water from Anderson Reservoir across Coyote Creek to Calero Reservoir and on to Los Gatos Creek. Thisproject has been discussed in a preceding portion of this report. Its estimated cost in this report is $9,870,000. Its 72 and 66 inch pipe would have sufficient capacity to meet present use and future needs for probably 20 years. This project is a good basis for an estimate of the cost of such conveyance.

This Cross Valley Project in the July 12, 1960, report would extend only to Los Gatos Creek. For service as far as Palo Alto an extension of about 75,000 feet would be needed. At a similar cost per foot to the Cross Valley Project, such an extension might cost $7,500,000. Some additional branches to individual cities would be needed which might increase the total cost to $8,500,000. While this represents only a very generalized estimate it has been used in comparisons of the cost of delivery by this route. No detail estimate is available.

The estimated cost of operation and maintenance for this Cross Valley Project is $37,400 per year equivalent to 0.38 per cent of its construction cost. The same basis has been used for the extension to Palo Alto.

This Cross Valley Project would divert from Anderson Reservoir at elevation 560 and cross Coyote Creek by an inverted siphon across Santa Teresa Hills to reach Calero Reservoir. Imported water from either a Pacheco Pass Tunnel or a South Bay Aqueduct would reach Coyote Creek where this line crosses it at elevation 350. A pumping lift of about 210 feet would be needed to place such imported water in this Cross Valley conduit. Flow from Calero Reservoir would be by gravity.

The estimated costs of conveying imported water from Coyote Creek to Los Gatos Creek in this Cross Valley Project for the same amounts of water used in other estimates is as follows: -

Interest and Amortization of bonds $9,870,000 at 4.65 per cent	$460,000
Pumping from 210 foot lift	$2.50 per acre-foot
Other Operation and Maintenance cost at 0.38 per cent	$ 37,400

Costs per acre-foot for different amounts of use would be as follows:

For use of 30,000 acre-feet per year	$18.85
60,000 " " " "	10.70
88,000 " " " "	8.15

Similar estimated costs for conveyance from Los Gatos Creek to Palo Alto would be as follows: -

Interest and Amortization of bonds $8,500,000 at 4.65 per cent	$395,000
Operation and Maintenance cost at 0.38 per cent	32,000
Total	$427,000

Cost per acre-foot for different amounts of use would be as follows:

For use of 30,000 acre-feet per year	$14.20
60,000 " " " "	7.10
88,000 " " " "	5.00

PIPE LINE FROM AIRPOINT RESERVOIR TO THE CITIES IN THE NORTHWESTERN PART OF SANTA CLARA COUNTY

Mr. Mark Thomas made a report for the Authority on this subject in April 1959. The results in this report have been used by the Review Board for the costs of this service. These results have also been used by the State in its statement of June 23, 1960.

Such a conduit would be used for municipal service only. Mr. Thomas presented two plans. Plan A would have a delivery capacity of 40,000 acre-feet per year and be duplicated in 1990 when it was estimated greater capacity would be needed. Plan B would be built with an initial capacity of 80,000 acre-feet per year. The capital cost of Plan A exceeded that of Plan B. The average cost per acre-foot of delivery for the rate of increase in demand used was $26.30 for Plan A and $29.40 for Plan B.

It has been previously concluded in this report that the present draft of these cities on their ground water is about 30,000 acre-feet per year and 13,000 acre-feet was purchased in 1959-60 from San Francisco. If these cities changed to using South Bay Aqueduct water for their entire present demand, an initial system capacity of 40,000 acre-feet would be inadequate to meet any increase in use. The estimated costs used by the Review Board have been based on Mr. Thomas' Plan B.

Mr. Thomas' results include $3,500,00 for the construction of Airpoint Reservoir which represents an annual charge of $5.10 per acre-foot for the delivery of water which he used. The State's estimated costs for delivery at Airpoint also include the cost of the Airpoint Reservoir. While it may be optional whether this reservoir should be built by the State or by local interests, the Review Board has included the costs in the State's results and has deducted them from Mr. Thomas' estimates.

Mr. Thomas estimates that the cost of the 134,000 feet of pipeline required for his Plan B would be $11,600,000, would have an annual capital charge of $540,000 for 50 year financing at four per cent and would have an annual operation and maintenance cost of 0.25 per cent of the construction cost equal to $29,000.

Mr. Thomas included the estimated cost of a water treatment plant in his results. Such treatment will be essential if this water is to be used for municipal purposes. It will be more economical to use one plant to treat the entire supply rather than for each municipal customer to treat its own supply separately. Mr. Thomas estimates that a treatment plant of 108 M.G.D. maximum capacity would cost $3,500,000, would have an annual capital charge of $162,925 for 50 year financing at four per cent, and would have an annual operation and maintenance cost of $6.00 per acre-foot treated. These estimates have been used by the Review Board for the cost of treatment.

Using the preceding cost estimates, the total annual costs and the costs per acre-foot for the same three amounts of delivery that have been used in other comparisons give the following results:

	Total Annual Costs	Cost per Acre-Foot
Interest and amortization of bonds - $11,600,000 @ 4.65%	$540,000	
Operation & maintenance at 0.25% of construction cost	29,000	
Total Annual Cost	$569,000	
For use of 30,000 A.F. per yr.		$19.00
60,000 " " " "		9.50
88,000 " " " "		6.50
Treatment Plant:		
Interest and amortization of bonds - $3,500,000 @ 4.65%	$162,900	
Operation & maintenance at $6.00 per acre foot	6.00	
Total Annual Costs		
For use of 30,000 A.F. per yr.		$11.40
60,000 " " " "		8.70
88,000 " " " "		7.85

SUMMARY

The preceding estimates of the annual costs per acre-foot delivered for water from the South Bay Aqueduct around the Valley at different points of delivery and for different amounts of use have been assembled in the following table.

	Estimated Costs per Acre-Foot for Annual Deliveries in Acre-Feet of		
	30,000	60,000	88,000
South Bay Aqueduct to Airpoint including Airpoint storage	$ 48.10	$30.80	$24.80
Conveyance Airpoint to Coyote Creek	15.00	7.50	5.00
Total cost at Coyote Creek	$ 63.10	$38.30	$29.80
Conveyance cost to Los Gatos Creek	18.85	10.70	8.15
Total cost at Los Gatos Creek	$ 81.95	$49.00	$37.95
Add conveyance to Palo Alto	14.20	7.10	5.00
Total Estimated Cost of Untreated Water delivered by a conduit around the Valley to Palo Alto	$ 96.15	$56.10	$42.95
Cost of treatment for municipal use	11.40	8.70	7.85
Total Estimated Cost of Treated Water delivered by a conduit around the Valley to Palo Alto	$107.55	$64.80	$50.80

NOTE: Delivery to Palo Alto is used to represent the delivery to the cities in the northern part of the North Santa Clara Valley.

For delivery by pipe lines to the cities in the northern portion of North Santa Clara Valley the estimated cost of water from the South Bay

Aqueduct would be as follows:

	Estimated Costs per Acre-Foot for Annual Deliveries in Acre-Feet of		
	30,000	60,000	88,000
South Bay Aqueduct to Airpoint including Airpoint storage	$48.10	$30.80	$24.80
Conveyance by pipe line across northern part of Valley	19.00	9.50	6.50
Total Estimated Cost of Untreated Water	$67.10	$40.30	$31.30
Cost of treatment for municipal use	11.40	8.70	7.85
Total Estimated Cost of Treated Water delivered by a pipe line across northern part of Valley to Palo Alto	$78.50	$49.00	$39.15

The preceding discussion and estimates assume that all cities in north Santa Clara County will use the same source of imported water. Should their service be divided between more than one source of supply, the costs per acre-foot for the reduced amounts of use will be increased.

PACHECO PASS TUNNEL ROUTE

After the State issued its reports on the Feather River Project, with its South Bay Aqueduct extending through the Livermore and Santa Clara Valleys to San Benito County, local interests began to look for more direct routes to bring water into the southern part of the area to be served. These investigations led to proposals for a tunnel under Pacheco Pass to deliver water at about elevation 400. Water from the outlet of such a tunnel could be conveyed to San Benito, Santa Cruz, and northern Monterey Counties. It could also be taken to the north to serve the South Santa Clara Valley and continued further to the north to be delivered into the system of the Conservation District for use in North Santa Clara Valley.

Based on these earlier studies, support developed for using a Pacheco Pass Route for all deliveries to the Santa Clara County areas in place of the South Bay Aqueduct as proposed by the State.

The State also investigated the Pacheco Pass Route and has reported some general results. The Water Authority has made an agreement with the U. S. Bureau of Reclamation for cooperative investigations which will include a report on this route for delivery of water to the areas which it may serve. The Authority also employed Creegan and D'Angelo to make investigations and cost estimates for a Pacheco Pass route.

The results of the State and of Creegan and D'Angelo have been available to the Review Board. The results to date of the U. S. Bureau of Reclamation have also been made available. As the Bureau has not as yet made its investigations of the location and costs of a Pacheco Pass Tunnel, the Review Board has used the results in the report of Creegan and D'Angelo in its cost comparisons. The water demands which such a tunnel route might serve have been estimated in various reports which have been reviewed by the Board.

All investigations of a Pacheco Pass Route have been based on the use of a tunnel under the Pass. The elevation of the Pass is 1,389 feet. The lift required to pump water over the Pass makes the use of a tunnel more economical than an open line over the summit for the quantities of water it is proposed to deliver. While more detailed studies may result in a final location either higher or lower than that selected by Creegan and D'Angelo, their results furnish a good basis for present comparisons with other proposed routes.

PACHECO PASS PROJECT PROPOSED BY THE STATE

Bulletin 3 "The California Water Plan" published in May 1957 shows the South Bay Aqueduct extending to San Benito County and ending at the Pajaro River. The State's investigations of a Pacheco Pass Route were made after the completion of Bulletin 3.

In "A Summary of Accomplishments of Water Program Funded Under Provisions of S. B. 1106", furnished to the 1959 legislature, included a Pacheco Pass Tunnel Aqueduct from a reservoir near Los Banos in Merced County to a terminus in Pacheco Creek in Santa Clara County with the following statement:

"Pacheco Pass Tunnel (Santa Clara, San Benito and Santa Cruz)

Capital Cost	$15,000.00
Date of Initial Water Delivery	1965
Quantity delivered in 1985	37,000 acre-feet"

The Policy Statement of the Department of Water Resources dated January 21, 1960, includes the following:

Pacheco Pass Tunnel Aqueduct

Estimated Annual Capital cost component	$980,000
Costs plus Delta Water Rate	$14.00

This capital cost component includes interest and amortization on the construction costs (4.65%), replacement, and a minimum or standby operation charge. The total capital component of $980,000 used in this statement is 6.53 per cent of the capital cost of $15,000,000. In recent cost estimates for delivery from the South Bay Aqueduct the State has used a capital cost component of 4.65% covering interest and amortization only.

For the delivery of 37,000 acre-feet per year used in the 1959 legislative report these estimates give a capital cost component of $26.50 per acre-foot using 6.53% and $19.00, using 4.65% and total charges at the tunnel outlet of $40.50 and $33.00 respectively per acre-foot. The expected delivery of 37,000 acre-feet per year would not be reached in San Benito County in the early years of project operation.

For a use of 83,000 acre-feet (66,000 to North Santa Clara Valley and 17,000 to San Benito County) the cost for delivery at the tunnel outlet would be the meter rate $14.00 plus $8.40 for the capital cost component of 4.65% equal to $22.40 per acre-foot. Costs for conveyance from the tunnel outlet to Coyote Creek would be additional to this cost.

Plan III of the 1958 Greydanus report of the State for conveyance of water from San Luis Reservoir through a Pacheco Pass Tunnel to San Benito and Santa Clara Counties had an estimated construction cost of $29,300,000, an annual cost of $1,690,000 and an average cost of $22.50 per acre-foot for the delivery of 75,000 acre-feet per year.

In a report entitled "Water Service to the Municipalities in Northern Santa Clara Valley, from the Proposed Airpoint Reservoir compared to

Service from the proposed Pacheco Pass Aqueduct to the same Municipalities" by George L. Sullivan dated April 20, 1959, the costs in the Greydanus report were used as the basis for the comparison of service from these two routes. This Sullivan report derived an average cost for the first 50 years of operation of $18.29 per acre-foot for water delivered by a Pacheco Pass Aqueduct to the Coyote Canal for an average delivery of 66,000 acre-feet per year. The total capital cost for this delivery was $20,416,000. These results were used to support a conclusion that the Pacheco Pass route was preferable to the South Bay Aqueduct for this service.

The estimated costs used in the Sullivan report do not conform to the basis of charges now being used by the State. The numerical comparisons in this April 1959 report are not comparable with present estimates.

Project From Delta-Mendota Canal

The most recent and detailed basis now available for estimating the cost of a Pacheco Pass Aqueduct is the report of Creegan and D'Angelo of March 1960. The estimates in this report are based on surface geological investigations by Frank W. Atchley discussed in his report entitled "Engineering Geology of the Proposed Pacheco Pass Tunnel" dated December 1958. Mr. Atchley's results were reviewed by Elmer C. Marliave.

Any tunnel through the Coast Range is hazardous. The length of the proposed Pacheco Pass Tunnel of six miles with the cover varying up to 1,000 feet precludes any exploratory drilling plan that will more than sample the formations that may be encountered. The Review Board has concluded that the investigations which have been made represent a thorough study insofar as surface conditions enable such investigations to be made and that Atchley's results regarding the nature of the formations that may be encountered represent as good a basis for estimating costs as can be secured without actual borings.

It is expected that the U. S. Bureau of Reclamation will make borings along the route or routes which they may conclude should be considered. Such borings were not scheduled by the Bureau until near the end of their program in 1962. The Board desired to have the results of such borings but all parties agreed that the report of the Review Board should not be delayed until the Bureau report had become available.

The Water Authority considered making such borings in 1960 and indicated its willingness to finance their costs if the Review Board considered them to be necessary for its work. After further consideration, the Board advised the Authority that the extent of borings whose cost could be justified at this time would represent only a sampling of the formations to be encountered and would not assure that all conditions along the tunnel route had been disclosed. The Board proposed that it should make its comparisons of the Pacheco Pass Route with other proposed routes on the basis of full concrete lining for its entire tunnel length. This basis should reduce the chances that the tunnel costs under actual construction would exceed the estimates used. This proposal was approved and the Review Board has proceeded on this basis.

The Creegan and D'Angelo report contains detailed estimates of quantities, classifications of material to be encountered and route studies. The cost estimates were reviewed and to some extent revised by Jacobs Associates and Augustine H. Ayers. The results are as complete and as well supported as any estimate that can be made at this time and have been used by the Board.

The capacities to be constructed for the initial stage of the project used for the different portions of this system are well selected. These are as follows:

	Second-feet
Tunnel - under low pressure	530
Pipe line - Delta Mendota Canal to tunnel inlet - 72" diameter, velocity 5.2 feet per second	150
Pipe line downhill from tunnel - excess grade available - 66" diameter, velocity 6.9 feet per second	163
Canal to connect with system of Santa Clara Valley Water Conservation District. Maximum capacity will operate canal at 150 second feet while only one pipe line is used until a second pipe is needed and built	325
Resulting initial delivery capacity. This is equivalent to 108,500 acre-feet per year if used to capacity continuously	150

The fully lined portions of the tunnel are designed with a horseshoe section having a nominal diameter of 11 feet. The design grade is 0.0006. For this size and grade the tunnel would have a capacity of 530 second-feet. For the unlined and gunited sections the nominal diameters are 13.8 and 13.5 feet respectively. For the friction factors applicable to these sections, grades of .00116 and .00067 respectively were used. When the capacity required exceeds that which can be secured from the constructed grade of .0006 it is planned that the additional grade required will be secured by placing the tunnel under pressure at its inlet. For the 30 per cent of the length estimated to be unlined the additional entry head would be about 17 feet.

These capacities represent deferring costs for the full capacity which will be needed ultimately for the portions of the aqueduct where additional pipe lines can be constructed economically later and building the tunnel and open canal to full size where enlargement would be costly. The initial delivery capacity of 150 second-feet should meet the demand for about 20 years.

The costs as estimated are those applicable to 1959 conditions. No specific allowances were made for inflationary increases. However, 33 per cent was added to the estimated bare unit costs for overhead and contractor's profit and 15 per cent for contingencies and 10 per cent for engineering were added to the direct costs. These allowances should leave some margin for inflationary increases.

A large part of the total cost will be the Pacheco Pass Tunnel. The Creegan and D'Angelo plan has an inlet elevation of the tunnel of 450 feet and an outlet elevation of 420 feet. These elevations give a tunnel length of 6.1 miles for the alignment used which has one angle to avoid some suspected poor ground. Borings and further studies relating to the economy of different elevations may alter this plan. Any changes will be made only if they improve the route used by Creegan and D'Angelo.

The estimated tunnel costs are shown in Table 11 for the three types of tunnel proposed. The cost estimates are based on 30 per cent of the tunnel length not requiring any lining, 30 per cent requiring only guniting, and 40 per cent requiring full strength concrete lining. While this anticipation may be realized, the character of the material to be encountered will not be fully known until the tunnel has been drilled. It is the opinion of the Review Board that costs based on only 40 per cent concrete lining are unduly optimistic for

TABLE 11

COST ESTIMATES FOR PACHECO PASS TUNNEL
BY
JACOBS ASSOCIATES AND A.H. AYERS
1959 COSTS

Costs per Linear Foot

Item	Unlined	Lined-Concrete	Lined-Gunite	Mean
Driving - Labor	$ 81.05	$ 81.05	$ 81.05	$ 81.05
Materials - Tunnel support	0	46.00	0	18.35
Job materials - powder	18.10	18.10	18.10	18.10
Equipment	6.90	6.90	6.90	6.90
Electric power	3.10	3.10	3.10	3.10
Total for Driving	$109.15	$155.15	$109.15	$127.50
Concrete lining	0	72.00	0	28.80
Gunite lining	0	0	26.50	7.95
Tunnel drain	0	16.00	0	6.40
Equipment cost	19.75	19.75	19.75	19.75
Plant	17.85	17.85	17.85	17.85
Grouting	5.00	5.00	5.00	5.00
Total	$151.75	$285.75	$178.25	$213.25
Assumed use of types of lining in per cent of tunnel length	30	40	30	100
Actual lengths in feet	9,666	12,888	9,666	32,220
Total Cost	$1,465,000	$3,685,000	$1,720,000	$6,870,000
Add overhead and profit - 33%	485,000	1,215,000	568,000	2,268,000
Total	$1,950,000	$4,900,000	$2,288,000	$9,138,000
Total Estimated Cost - Lin. Ft.	$202	$380	$236	$283
Cost if all of each type	$6,500,000	$12,250,000	$7,600,000	

These estimated costs do not include 15% for contingencies and 10% for engineering.

any tunnel in the Coast Range for which adequate advance borings have not been secured. As previously discussed the Board has based its estimates on full concrete lining of the entire length of the tunnel. This is the only item on which the Board has departed from the estimate of Jacobs and Ayers.

The mean cost shown in Table 11 is for the extent of unlined, gunited, and fully lined lengths used in the cost estimate. The estimated cost per foot of each type is shown in the lower portion of the table. The fully lined section has an estimated cost per foot of about 1-3/4 times that of the average of the other two types.

The last line in the table gives the estimated costs if the entire length of the tunnel should be of each of the three types. Complete concrete lining gives an estimated cost $3,112,000 greater than the division of the three types used by Jacobs and Ayers. This increase has been used by the Board in its estimates. This difference is applicable to the estimated contract costs before the estimated cost of engineering and contingencies has been added; this increases the total difference in cost to about $4,050,000.

Allocation of Costs

An allocation of the estimated costs of the Pacheco Pass Route to the three areas it is proposed to serve is needed in order to compare costs to each area of alternate projects. All works to Station 788, the tunnel outlet, will be used for all deliveries. The Creegan and D'Angelo report does not include costs of conveyance from Station 788 to San Benito and Santa Cruz Counties. Such costs are a necessary part of their cost for delivered water. As the purpose of the Creegan and D'Angelo report was to secure estimated costs for use in comparisons of different sources of supply for North Santa

Clara Valley, they included conveyance from Station 788 to a terminus where water could be delivered to the system of the Conservation District where its proposed cross valley conduit crosses Coyote Creek.

Water from the tunnel can be delivered into Pacheco Creek at the tunnel outlet. The Creek can be used for conveyance to any desired point of diversion in San Benito County. Similar delivery from the tunnel could be used for conveyance to Santa Cruz County. However, maintenance of the tunnel outlet elevation may be needed for best delivery conditions to these areas. Creegan and D'Angelo have planned to convey water for other deliveries than North Santa Clara Valley in a pipe from the tunnel outlet to Station 1700. These differences in the available points of delivery for other areas affect the allocation of costs for the jointly used works. The conduit to the north from Station 1700 can also be used by the South Santa Clara Valley. However, no present need is considered to exist in this area and no allocation of costs has been made to it.

The following table segregates the estimated costs in accordance with the divisions described above:

Estimated costs to Station 788, the tunnel outlet:

Rights of Way, Parcel 3 - Garrod	$ 25,000
72" pipe line to tunnel - Ayers $4,515,500 + 33%	6,005,600
Tunnel - All concrete lined - Review Board's adjustment	12,250,000
Pumping Plant at Delta Mendota Canal $457,200 + 33%	610,000
	$ 18,890,600
Construction Contingency - 15%	2,833,300
Engineering at 10%	1,889,100
Total	$ 23,513,000

The cost of the 66 inch pipe line from the tunnel outlet to Station 1700, including the 33 per cent contractor's overhead and profit, from the Jacob and Ayers estimate is $ 8,372,400

Rights of Way	15,800
Construction Contingency - 15%	1,258,200
Engineering - 10%	838,800
Total	$ 10,485,200

The estimated costs for the conduit from Station 1700 to its terminus in North Santa Clara County have been taken from the Jacobs and Ayers report. These are as follows:

Rights of Way and Buildings	$ 490,600
Canal	4,749,000
Pumping Plants	455,000
Total	$ 5,694,600
Construction Contingency - 15%	854,000
Engineering - 10%	569,000
Total	$ 7,117,600

The estimated construction costs, segregated to the three portions for which separate cost allocations have been made, are as follows:

Delta Mendota Canal to Tunnel Outlet	$23,613,000
Tunnel Outlet to Station 1700, the take-out for Santa Cruz County	10,485,200
Station 1700 to terminal of north extension on Coyote Creek	7,117,600
Entire Project	$41,215,800

These estimated costs agree with those of Jacobs and Ayres except for the addition of about $4,000,000 by the Board for concrete lining for the full length of the tunnel. For a use of 66,000 acre-feet per year, this increased cost for tunnel lining represents about $3 per acre-foot of annual delivery.

The preceding estimates represent the capital cost which will need to be incurred for the project proposed. Interest, amortization, replacement costs will be a part of the charges for water.

The project investigated by Creegan and D'Angelo represents the only one available under present conditions as the Delta-Mendota Canal is the only presently available source of water supply for the tunnel. The Jacobs and Ayers cost estimate does not include any costs for water to be taken from the Delta-Mendota Canal. Of necessity, water has to be pumped about 380 feet from about elevation 179 feet at the Delta-Mendota Canal to the portal elevation of the tunnel inlet of 460 feet. A pressure line about nine miles long is required for such delivery. About five miles of this line is located in the site of the proposed San Luis Reservoir. This portion of the line has an extra shell of concrete seven inches thick to give it weight to resist flotation. The additional estimated cost of this shell is $1,070,000.

The project in the Creegan and D'Angelo report is not directly comparable with that included by the State in its Feather River Project. The State project would divert from the San Luis Reservoir with less lift and shorter length of pipe line to the tunnel. Whether the costs under the State project for delivery of water into San Luis Reservoir and into the tunnel inlet will be more or less than those under the Creegan and D'Angelo plan will depend on the allocation of costs by the State for placing water in the San Luis Reservoir and the charges the Bureau may make for water delivered from the Delta-Mendota Canal.

All uses would participate in costs to the tunnel outlet. Additional costs would be required for delivery to the points of use in the areas to be served. Fixed charges on the $23,600,000 estimated cost to the tunnel outlet would be about $1,100,000 per year. For the 37,000 acre-feet of use in 1985 estimated by the State, such fixed capital charges alone would be about $29.50 per acre-foot. In the earlier years of less use this cost per acre-foot would be increased. Costs of power for pumping, for operation and for the local distributional systems needed would be additional and increase the delivered cost to or in excess of $50 per acre-foot. These costs would be for untreated water from the Delta-Mendota Canal suitable for irrigation or ground water recharge but not potable for direct use for municipal or industrial purposes.

For a Pacheco Pass Project for use in North Santa Clara County, the larger total use would reduce the per acre-foot charge for the capital cost component. Construction costs would be allocated among the areas to receive water on the basis of their relative use of the constructed facilities.

All users of this project would participate in costs up to the tunnel outlet. Costs between the tunnel outlet and Station 1700 would be divided between North Santa Clara Valley and any other areas that may take water beyond the tunnel outlet. All costs beyond Station 1700 would be chargeable to the North Santa Clara Valley. Joint costs would be divided in proportion to the use each area may make of the joint facilities.

The capacity of the initial construction is about 100,000 acre-feet per year. Costs may be divided on the basis of this capacity or allocations might be made on the basis of the costs of the ultimate use for the portions of the project built to full capacity.

There is no specific basis now available on which the division of use of the initial capacity of the Pacheco Pass Project of Creegan and D'Angelo can be made between San Benito and Santa Clara Counties. It has been estimated that San Benito County has a present demand of 14,000 acre-feet per year and might purchase this supply in the initial years of such a project. In later discussion of use by San Benito County its average use during the repayment period has been assumed to be 17,000 acre-feet per year. The demand for North Santa Clara Valley in the initial years may be 50,000 acre-feet. The demand in North Santa Clara Valley will probably increase more rapidly than in San Benito County.

For purposes of present estimates it has been assumed that about 80 per cent of the cost of the jointly used features of the Pacheco Pass

Project will be allocated to North Santa Clara Valley and 20 per cent to San Benito County. On this basis the average use during the repayment period would be 66,000 acre-feet per year for North Santa Clara Valley. It is also assumed that San Benito County will take its delivery at the tunnel outlet. No allocation in the initial project has been made to Santa Cruz or Monterey Counties or South Santa Clara Valley.

On this basis the construction cost would be allocated as follows:

To North Santa Clara County -	
80% of costs to Tunnel Outlet	$18,890,000
100% of costs, Tunnel to Station 1700	10,485,200
100% of costs, Station 1700 to end	7,117,600
Total	$36,492,800
To San Benito County -	
20% of costs to Tunnel Outlet	4,723,000

Total Estimated Costs of Delivered Water

The price of water from the Delta-Mendota Canal has generally been $3.50 per acre-foot for irrigation and $10 for municipal and industrial use. For present purposes it has been assumed that the price of water from the Delta-Mendota Canal for use by the Pacheco Pass Project, planned in the Creegan and D'Angelo report, will be $3.50 per acre-foot. for percolation to the ground water. If the ground water use is for municipal and industrial purposes the higher price will apply.

Water pumped from the Delta-Mendota Canal to the Tunnel Inlet will have a static lift of 390 feet. The cost of this pumping will depend on the source of power that may be used. If power should be obtainable at the rate charged by the Bureau in its accounting for the pumping in the Central Valley Project the cost of power will be about $2.00 per acre-foot for pumping for irrigation. For the purchase of public utility power available in this area under high load factor operation the cost of power may be about $5.00 per acre-foot.

There will be additional pumping for water taken to North Santa Clara Valley. The lift at the Rucker Avenue Pumping Plant will be about 125 feet. The water pumped will be 80 per cent of the project total if 20 per cent is delivered to San Benito County. The cost of public utility power for this left may be $1.50 per acre-foot.

Cost of operation and maintenance other than the cost of power may be $1.50 per acre-foot.

Capital charges will depend on the method of financing used. For comparison with a state financed South Bay Aqueduct the capital cost component covering interest and amortization for 50 year bonds at 4 per cent would be 4.65 per cent.

Combining these items gives the following estimated costs for water conveyed to the points of delivery to the local agencies. Costs for local distribution would be additional to these results.

	No. Santa County	San Benito County
Capital Cost Component - Total	$1,700,000	$220,000
Estimated mean use in repayment period - acre-foot	66,000	17,000
Capital Cost Component per acre-foot	$25.80	$13.00
Cost of Power per acre-foot	6.50	5.00
Cost of Operation per acre-foot	1.50	1.50
Price of Water at Delta-Mendota Canal	3.50	3.50
Total Cost per Acre-Foot	$37.30	$23.00

The preceding estimates indicate that this Pacheco Pass Project based on serving San Benito County alone or with some use in Santa Cruz County will not have a sufficient demand for water to bring the costs within the value of the use of the water for irrigation if construction funds are secured on a four per cent interest basis. What such costs might be for a Bureau project under federal terms cannot be estimated at this time but may be available when the Bureau completes its current investigations in 1962.

The cost of water to San Benito County may be materially reduced if service to North Santa Clara Valley is included in amounts representative of its probable use. The estimated cost even for this type of project when increased for the cost of local distribution are higher than it can be expected irrigation will be able or willing to pay.

For North Santa Clara County service from a Pacheco Pass Project diverting water from the Delta-Mendota Canal, using four per cent interest rate funds for its construction results in an estimated cost for the use of 66,000 acre-feet of $37.50 per acre-foot delivered into Coyote Creek. This would be for water suitable for irrigation or for percolation to the ground water but not for direct municipal use without treatment. Costs for distribution from Coyote Creek would be added to the above cost.

For the South Bay Aqueduct, costs per acre-foot of use have been derived previously for uses of 30,000, 60,000 and 88,000 acre-feet per year. Similar results can be computed for the Pacheco Pass Routes. This has been done in the following table.

ESTIMATED COSTS PER ACRE FOOT OF ANNUAL DELIVERY

	Amount of Annual Use in Acre-Feet		
	30,000	60,000	88,000
Water from Pacheco Pass Project pumping from Delta Mendota Canal and delivering to North Santa Clara Valley at Coyote Creek			
Interest and Amortization on Bonds $36,492,800 @ 4.65% Total Annual Cost $1,690,000	$56.00	$28.00	$19.00
Cost of Power for pumping	6.50	6.50	6.50
Cost of Operation and Maintenance	1.50	1.25	1.00
Purchase of Delta Mendota Canal water	3.50	3.50	3.50
Total Cost	$67.50	$39.25	$30.00

Pacheco Pass Project Diverting From San Luis Reservoir

The project that has been discussed has been based on pumping water from the Delta-Mendota Canal. While the elevation to which the water will have to be pumped is controlled by the elevation of the tunnel, the construction of the San Luis Reservoir will reduce the separate lift to the tunnel. The San Luis Reservoir would also avoid the need for the pipe line from the Delta-Mendota Canal through the San Luis Reservoir site.

The conditions under which the San Luis Reservoir may be constructed and operated are currently under negotiation between the State and the Bureau. If the San Luis Reservoir is constructed before a Pacheco Pass Project, the plan for a Pacheco Pass Project which has been proposed by the State would become applicable.

As previously discussed, the State has estimated the construction cost of a Pacheco Pass Tunnel project from San Luis Reservoir at $15,000,000 with an annual capital cost component of $980,000 and a water rate of $14 per acre-foot. This project includes construction and delivery only to the tunnel outlet. For the 37,000 planned to be delivered a total cost becomes $40.50 per acre-foot.

The report of Creegan and D'Angelo can be used to furnish an estimate of the cost of a similar project by selection of the applicable items. This report, with the increased cost added by the Review Board for full concrete lining of the tunnel, has an estimated cost of $23,613,000 to the tunnel outlet. Of this cost $8,300,000 would be for works to deliver water to the tunnel inlet and $13,313,000 for the tunnel. A lower head pumping plant and works to deliver water to the tunnel would be needed with San Luis Reservoir. No specific plan and estimate for such works is at hand, and an assumed cost of $1,000,000 has been included. On this basis, the cost as estimated in the Creegan and D'Angelo report would be $16,300,000 for works comparable with the State's estimate of $15,000,000. This is as good an agreement as can be expected in the estimated costs of works involving as much uncertainty as a Pacheco Pass Tunnel. It is concluded that the costs to San Benito County of a project diverting from San Luis Reservoir as estimated by the State are in general agreement with the results used by the Review Board.

For a project diverting from San Luis Reservoir used to deliver water to North Santa Clara Valley through a Pacheco Pass tunnel an interpolated estimate can be prepared based on the results of Creegan and D'Angelo for diversion from the Delta-Mendota Canal. This has been done by using the State's results for delivery of water to the tunnel outlet and adding the costs in the Creegan and D'Angelo report for conveyance to North Santa Clara Valley. The results are shown in the following table.

	North Santa Clara County -80%	San Benito County 20%
Estimated mean use in repayment period - acre-foot	66,000	17,000
Total Annual Capital Cost component used by State of $980,000 divided 80%, 20%	$784,000	$196,000
Capital Cost component - per acre-foot	$12.00	$12.00
Water Rate	14.00	14.00
Costs for delivery to North Santa Clara Valley -	100%	0%
Capital Cost	$17,600,000	
Annual Capital Cost component	1,150,000	
Capital Cost component - per acre-foot	$17.50	
Cost of Operation including pumping	3.00	
Total Cost Per Acre-Foot	$46.50	$26.00

These estimates are not materially different from those derived for pumping from the Delta-Mendota Canal. This is the result of the near agreement between the State's water rate of $14 per acre-foot for water at the tunnel outlet with the estimated cost of purchase and pumping of water from the Delta-Mendota Canal. These estimates are based on the capital cost component of 6.53% used by the State in its 1960 results.

The estimated annual costs per acre-foot of use for the same three amounts of delivery that have been used for other companies can be derived for a Pacheco Pass Route taking water from San Luis Reservoir. This has been done in the following table. In these results the capital charges for 4 per cent, 50-year bonds of 4.65% per year have been used.

ESTIMATED COSTS PER ACRE FOOT OF ANNUAL DELIVERY

Water from Pacheco Pass Project pumping from San Luis Reservoir into Tunnel and Delivering to North Santa Clara Valley at Coyote Creek	Amount of Annual Use in Acre-Feet		
	30,000	60,000	88,000
State's estimated cost to tunnel outlet - $15,000,000 Interest and amortization on bonds @ 4.65% = 700,000	$23.30	$11.70	$ 8.00
State's Meter Rate	14.00	14.00	14.00
Estimated Cost at Tunnel Outlet	$37.30	$25.70	$22.00
Conveyance to Coyote Creek -			
Estimated construction cost $17,600,000. Interest and amortization on bonds at 4.65% = $820,000	27.30	13.70	9.30
Estimated cost of operation including pumping	3.00	3.00	3.00
Total Costs to Coyote Creek	$67.60	$42.40	$34.30

The different estimates that have been discussed for delivering water at Coyote Creek from a Pacheco Pass Project are shown in the following table.

ESTIMATED COSTS PER ACRE FOOT OF ANNUAL DELIVERY

Projects based on 50-year 4% bonds	Amount of Annual Use in Acre-Feet		
	30,000	60,000	88,000
Pumping from Delta-Mendota Canal	$67.50	$39.25	$30.00
Pumping from San Luis Reservoir	67.60	42.40	34.30

These results are based on using $3.50 per acre-foot for the purchase of water from the Delta-Mendota Canal and $14.00 per acre foot for the cost of delivery of water to San Luis Reservoir and the operation and maintenance of the Pacheco Pass Project. Due to these differences, the results are not directly comparable. It is concluded that the cost of water for a Pacheco Pass Project using diversion from the San Luis Reservoir should, and probably would be, less than that for diversion from the Delta-Mendota Canal.

For comparison with water delivered at Coyote Creek through the South Bay Aqueduct, the estimated cost for delivery through a Pacheco Pass Project has been assumed to be as follows:

	Cost Per Acre-Foot
For use of 30,000 acre feet per year	$67.50
60,000	42.00
88,000	34.00

For each of these amounts of use, the estimated costs used by the Review Board includes its increase in the estimated cost of the Pacheco tunnel of about $4,000,000 equivalent to a total annual charge of $186,000. This represents from $6.20 to $2.10 per acre-foot for the above amounts of use.

There are no present cost estimates available for water from the San Felipe Division of the federal Central Valley Project. Investigations are under way by the Bureau with the report scheduled for completion in July 1962. The report of Chas. T. Main, Inc. of October 1960 (p. 2-2) states:

> "The Pacheco Pass Tunnel Aqueduct, included in the Burns-Porter Act, is expected to be built by the Bureau of Reclamation and is now under study by that agency."

WATER SUPPLY OBTAINABLE FROM SAN FRANCISCO FOR USE IN NORTH SANTA CLARA VALLEY

Water is now available for purchase for municipal uses in the northern portion of North Santa Clara Valley from the existing facilities of San Francisco's Hetch Hetchy water system. In order that the Review Board might compare this source with alternate supplies, it prepared a statement of its understanding of the conditions and terms under which Hetch Hetchy water would be sold in this area by San Francisco. This statement was submitted to the San Francisco Water Department for their review and correction if needed. The Review Board has also been furnished with the rate schedules and other documents pertinent to this service. From these inquiries and results the Board has what it understands to be the official position at this time of San Francisco relating to the availability of delivery and price at which water may be purchased from San Francisco for municipal use in Northern Santa Clara County. The Board has used this information as representing the terms and conditions on which water is available for purchase from San Francisco within its area of service.

The Hetch Hetchy system was not built to the capacity of its sources of water supply in its initial construction. Additional conveyance capacity was deferred until the use of water had increased. Additional facilities can be constructed to meet increased use. The sources of supply on Tuolumne River are adequate to provide the water to meet additional demand. Water from the San Francisco system represents a known supply already available in an amount adequate to meet present demands and readily enlarged to meet increasing demands.

The present capacity of the Hetch Hetchy system and the other local sources of supply is now approaching full use. San Francisco contemplates increasing its capacity to convey Hetch Hetchy water to its area of service. Should a period of deficient local runoff occur the present demand may approach or exceed the supply obtainable with the present works. The use of water in San Francisco is increasing at a slower rate than that of the outside service areas. The total demand will require an increase in the capacity of the Hetch Hetchy system within a few years. This need justifies immediate planning and construction of the works required if long term contracts for sale of water are secured.

Hetch Hetchy water comes from a drainage area having as small sources of pollution as can be found under present conditions. It is of good chemical quality. As delivered it is a potable supply usable domestically without further treatment except chlorination.

The pipe lines of San Francisco cross the southern end of San Francisco Bay and also go around the south end of the Bay so that water is now available for delivery directly into the systems of the cities along the route of these pipe lines. Several of these cities and other public agencies in Santa Clara County now purchase part of their total use from San Francisco. An increase in these purchases by these cities would involve little if any increase in capital costs to the purchasers for additional delivery facilities.

In 1959-60 the total system input of the San Francisco Water Department for both inside and outside use was 191,622 acre-feet. Of this total, 103,836 acre-feet or 54 per cent was delivered within San Francisco County.

This total delivery was equivalent to a mean flow of 171.03 M.G.D. The safe sustained annual delivery capacity now available through existing facilities is estimated by the City to be 180 M.G.D. on a conservative basis with a delivery capacity of 214 M.G.D. in a year of average water supply and a present peak delivery capacity of 350 M.G.D.

San Francisco has additional works scheduled for construction as they may be needed to develop its additional sources to meet the increasing needs. These works include additional storage and pipe lines with a second tunnel through the Coast Range as the final stage in this development.

To date San Francisco has expended in excess of $200,000,000 on its present water system including distribution. It is estimated that this system when completed will represent a total investment of over $400,000,000. The present program of San Francisco to 1983 involves the issuance of $115,000,000 of general obligation bonds to be serviced from water and power revenues.

The conditions under which San Francisco may sell Hetch Hetchy water for use outside of its own boundaries are restricted under the terms of the Raker Act governing the use of federal lands in Yosemite National Park. Such water may not be sold for use outside of the San Joaquin Valley for agricultural use. This restricts its purchase in North Santa Clara Valley to use for municipal or industrial purposes. Such sales can be made only to public agencies. Water purchased from San Francisco is not an alternate source for ground water recharge for irrigation draft. While it is expected that irrigation will be replaced by urbanization in this area, the demands for irrigation both present and until urbanization may be completed, requires that water be secured for its use as well as for municipal purposes.

The preceding comments regarding Hetch Hetchy as a supply for cities in Northern Santa Clara County have described its availability and quality. On these items the comments have been favorable. There remains to be discussed the items of price and assurance of permanent service.

The present area of San Francisco is largely developed and is approaching its probable ultimate use of water. It has incurred a large cost for a water supply system from the Sierras which has a present capacity adequate for the probable future needs of the city alone. Enlargement of the present system is not needed at this time if present sales outside of the city should be restricted or stopped.

San Francisco operates its water system in two parts. Its Hetch Hetchy System includes all works to the vicinity of Irvington Portal. The San Francisco Water Department receives water from the Hetch Hetchy System and distributes it to the users both within and without San Francisco. Delivery to Northern Santa Clara County involves use of the Hetch Hetchy Division and the main pipe lines to the water service to each user but does not involve the use of San Francisco's Peninsula System. In its own accounting between its Hetch Hetchyand San Francisco divisions, the San Francisco Water Department is charged and the Hetch Hetchy System is credited at a rate of about $40 per acre-foot delivered.

The difference between this rate and that charged for delivery to outside customers covers the costs for the maintenance and operation of the local system which is integrated with the Hetch Hetchy System to enable San Francisco to continue to serve its customers in case of non-delivery of water from Hetch Hetchy. Such local works include Calaveras Reservoir, Sunol

Filter Beds, the Pleasanton Well System and the future San Antonio Reservoir. It also includes the costs of the city distribution system.

On January 14, 1957, San Francisco issued a statement of its policy relating to the California Water Plan in which it stated that it would support the plan provided that, among other conditions, it did not interfere with the City's vested water rights on the Tuolumne River, did not interfere with its sale of water "for primary and supplemental domestic and urban purposes in the area within which San Francisco is now supplying such services, as requested, and within which San Francisco is able to continue such supply to ultimate requirements." It also conditioned such support on the charges to proposed water users from the State project being sufficient "to cover all costs equitably allocable thereto." This statement had a map attached to it on which the City's definition of its service area was shown. For areas outside of San Francisco this included areas in San Mateo, Santa Clara, and Alameda Counties. In Santa Clara County this service area covered all of the northern part of the county extending generally to the northern boundaries of the City of Santa Clara.

In 1959-60 San Francisco sold the following amounts of water in Santa Clara County to:

	Acre-Feet
Palo Alto	5,383
Oak Hills County Water District and	14
Purissima Hills County Water District	37
Mountain View	1,636
Moffett Field	1,377
Sunnyvale	2,891
Agnew State Hospital	19
Milpitas County Water District	1,495
Other water delivered in Santa Clara County	234
Total	13,286

These users include all of the public systems in northern Santa Clara County in the Pressure Area, except Monte Vista, for which it has been concluded, in preceding portions of this report, that surface service is needed to meet present ground water overdraft.

San Francisco's water rates are established by its own Public Utility Commission. The rate making authority of this Commission cannot be restricted by rates agreed to by the Water Department and a contracting customer. While the Department may and is ready to enter into long term contracts for delivery to outside users it cannot include rates which will not be subject to change during the life of the contract.

San Francisco water sold outside the City is at rates and service not subject to regulation by the State Public Utility Commission. The sale of water to outside users being voluntary on the part of San Francisco enables it to specify the price of water and the conditions of service which it will accept. The lack of any rate procedures in which the outside users could be heard before an agency having jurisdiction over the city has been one of the factors that have complicated the negotiations between San Francisco and its outside customers.

San Francisco uses a form of application for water supply for resale purposes which is made by the prospective user and, when accepted by the city, becomes binding on both parties. Service for resale is limited to governmental agencies under the terms of the Raker Act. Service is also limited to domestic or other municipal purposes. All outside service is subject to proration at times of shortage. The city has stated its willingness to make contracts for 20 years and is seeking such contracts to insure sales for the period for which bonds for increased facilities may be issued. Applications may be made for water to meet all of the applicant's water requirements. Use of this option requires the applicant to agree not to buy any water from other sources. Under another option, applications can be made for the continuation of the past service that has been received. A third option is an application for deliveries on a defined schedule. At the expiration of the service period of any application, the service may be extended or modified by mutual consent. If not extended the applicant is guaranteed the continuation of the amount of service received in the last year of the expired application. Payment is to be made at the current rates and is subject to the rules and regulations of San Francisco. If San Francisco does not construct the betterments necessary to keep the supply ahead of the use, a procedure is provided permitting the applicant to cancel the contract represented by the application.

The provisions of this service agreement which have caused the most discussion among prospective outside purchasers of water from the San Francisco Water Department have been the absence of an outside procedure for rate fixing and the dependence for future increases in supply on the willingness of San Francisco citizens to vote bonds for the construction of the necessary Hetch Hetchy facilities. It is understood that charter provisions prevent the submission of rates for outside sales to an outside rate fixing body and thus limits outside users to action through the regular courts if controversies over rates should arise. Such actions would be expensive and uncertain in their outcome.

As the capacity of the present system is in excess of the needs of San Francisco alone, its voters may not care to incur bonded debt to construct works for outside sales.

Aside from the questions involved in long time contracts regarding rates for the sale of water by San Francisco to outside users, there it little question of the future physical availability of a surplus supply for such sale. The rights of San Francisco to its Hetch Hetchy supply are well established since the settlement of former differences with the irrigation distrists using Tuolumne River Water. The dependability of the supply is also established. The rights to the Hetch Hetchy supply are more fully established than those for any of the other proposed sources of imported water.

Present sales by San Francisco are to each of its customers in North Santa Clara Valley separately. Each customer has its own delivery point and meter. No joint action on the part of these customers has been required to secure their present service and none has been proposed for future service from San Francisco. As San Francisco has constructed the works required for these deliveries, no incurrence of debt by these cities has been required in order to secure this service.

Allpresent service by San Francisco in Santa Clara County is now on a year to year basis. San Francisco has stated that it will not cut off present service.

San Francisco estimates that the average annual consumption of the area in Santa Clara County which it proposes to supply will be 47.2 M.G.D. equivalent to 53,000 acre-feet in 1980 and ultimately 103.0 M.G.D., or 116,500 acre-feet. The San Francisco Water Department states that "subject to future bond elections, (it) is prepared to sell water for primary and supplemental domestic and urban purposes in the area within which it is now supplying such services as requested and within which San Francisco is able to continue such supply to ultimate requirements ..... All areas served are on an equal priority basis."

The above estimated amounts of use appear to be based on a projected rate of use with the present use of ground water continued. In the report of July 12, 1960, of the Conservation District the estimated total use for the same cities in 1980 is about 90,000 acre-feet and in 2010 about 130,000 acre-feet.

To date outside sales by San Francisco have been made at rates that are only slightly higher than those applicable to customers within the city. These rates follow the usual basis and are scaled both on the delivery capacity and the extent of use. There is a monthly service charge based on the size of the meter and a sliding scale price on the amount of water taken decreasing with increases in the quantity used. The present rate schedule extends to 16 inch meter service and the rates for this size of service have been used in sales to the cities in northern Santa Clara County.

This form of rate schedule results in variable total costs for water each month depending on the amount of water taken. This makes comparison with the cost of alternate sources dependent on assumptions regarding the amount of water which may be bought each month. The comparisons used in this report have considered this factor but have been made mainly on the price of water for sufficient amounts of use to secure minimum rates. If the purchasing city has adequate service storage within its system or available ground water pumping capacity, it can take its purchased supply at rates which will result in base rate costs.

The present rate schedule of San Francisco was adopted in January 1960. This is the schedule which this Review Board has been advised will be the basis of sales to Santa Clara County users now under negotiation. The Board has used this schedule in its review of alternate sources. Its comparisons have been based on the rates for delivery through 16 inch meters.

Monthly charges under this schedule for inside service within San Francisco through a 16" meter consists of a service charge of $203.20 and a meter charge varying from 30.5 to 21.2 cents per 100 cubic feet for total deliveries up to 333,300 cubic feet and 15 cents per 100 cubic feet for all larger amounts. For service outside of San Francisco these meter rates are increased one cent per 100 cubic feet. For outside service a use of 333,300 cubic feet per month at this schedule results in an average price of $41.20 per million gallons or $126 per acre-foot. For a rate of continuous use of 1 M.G.D., equal to 92 acre-feet per month, the average price becomes $74.38 per acre-foot. For all use above the first 333,300 cubic feet per month the meter rate is $69.76 per acre-foot. The variation in these results based on the amount of use has caused differences in the cost figures which have been used in different reports.

For the fiscal year 1957-58 the average revenue per acre-foot of the San Francisco Water Department from customers in San Francisco was $144.50 for residential use and $100 for commercial and industrial use.

For the sales in the Bay Division in larger quantities for resale by public agencies, the average revenue was $74. 00 per acre-foot.

As the amounts of water being considered as the demands of the cities in Northern Santa Clara County are large enough to place their service in the minimum rate bracket, the Board has used a general cost of $70. 00 per acre-foot for purchase of water from San Francisco in its comparisons with alternate sources.

The rates charged by San Francisco to its outside customers are only slightly higher than those charged to its own residents for equivalent service. The inside rates include service to individual meters and for fire protection. The outside cities are subject to the costs of their local distribution systems in addition to the price paid to San Francisco. This difference is offset partially by the difference in rates based on the quantity used. The average price, including service charges for all water sold within San Francisco for delivery to individual customers in 1958, was reported to be about $120. 00 per acre-foot. The difference of about $50. 00 per acre-foot between this price and the wholesale price for outside customers represents the average charge for distribution service within San Francisco.

Municipalities purchasing water from San Francisco have their own local distribution systems and are subject to its costs in additional to the wholesale cost of the water used. Such local distribution costs are applicable to all sources of supply. The wholesale rates at which water may be purchased from San Francisco or from any other supplier does not represent the total costs to the individual customer.

In its comparisons of service in Santa Clara County by the San Francisco Water Department with other prospective sources of supply, the Review Board has accepted the terms and conditions now used by San Francisco as the basis on which such service can be secured. As San Francisco is not required to supply such outside service to meet future demands it can set the terms on which it will be supplied.

For such comparisons the following characteristics of service by San Francisco are applicable.

1. The price of water under present rates in the quantities which have been used by the prospective purchasers has been about $74 per acre-foot. The rate applicable to purchasers for average supplies large enough to be served by a 16 inch meter with continuous service may be as low as $70 per acre-foot.

2. The supply is dependable, the title of San Francisco to its use is well established and the present system has been in use long enough to demonstrate the dependability of its operation.

3. The water is of high quality minerally and required only chlorination for its domestic use.

4. The water is now available and its delivery is not dependent on the uncertainties of the State's construction program.

5. Water from San Francisco is available only for municipal and industrial uses and cannot be used to meet agricultural needs in adjacent areas. Water from San Francisco is available only in the northern part of North Santa Clara Valley and cannot meet the municipal needs of the whole area.

6. Purchasers of water from San Francisco will not be required to incur any debt for the cost of imported water as the present and future works required for such delivery have been and will be financed by San Francisco.

7. Water from San Francisco is available to the agencies eligible to purchase it individually without requiring any joint organization or mutual obligations with other agencies.

INVESTIGATIONS OF SAN FELIPE DIVISION OF CENTRAL VALLEY PROJECT OF U. S. BUREAU OF RECLAMATION

Under cooperative agreement with the Authority, the Bureau is now making investigations of service to this area through a Pacheco Pass Route as a unit of its Central Valley Project. These investigations are now scheduled for completion in July 1962.

In its 1959 Annual Report of the Central Valley Project the Bureau states that this investigation covers the bringing of supplemental water from the Central Valley Project to approximately 300,000 acres in San Benito, Santa Clara, Santa Cruz and Monterey Counties. Work was started in June 1959. Existing data on land surveys, aerial photography, geology, ground water, surface water and agricultural surveys are being assembled and reviewed. Studies are proceeding on an inventory of local water supplies and future requirements with consideration of alternate plans of development. The map of this division in this report shows diversion from the San Luis Reservoir with the proposed delivery through a Pacheco Pass Route.

The portion of the Bureau's results which have been completed have been made available for use by the Review Board and have been very helpful in its work.

A federal reclamation project for the Authority service area can only be discussed at this time in general terms as no estimated costs are available. The Bureau operates under well established federal law. This defines the conditions under which any such federal projects would operate and enables some forecasts to be made regarding what can be expected if the Bureau's investigations result in their finding a project on which their feasibility conclusion is favorable.

For Bureau projects the benefits must exceed the costs and the charges for irrigation must be within the ability to pay for the services to be supplied. Both of these findings should be favorable, as the area to be served by this Division is highly developed agriculturally and is rapidly becoming urbanized. As previously stated, the Review Board considers that the more highly developed parts of this area have the financial ability to pay the costs which may be necessary to secure their required water supply.

The costs allocated to a San Felipe Division of the Central Valley Project may be different than the costs that would be allocated to a separate project.

General Central Valley Project power earnings may be used to reduce the charges for water for irrigation. The charge for power used in pumping the water to the areas of service may be less than commercial rates. These rates may be materially lower than those at which the surplus Central Valley commercial power is now being sold to other agencies. Cost for power for pumping irrigation water does not include interest on its capital cost.

Repayment for project construction costs are usually extended over 40 years and may include an initial development period of 10 years before repayment begins. For irrigation, repayment is without interest. This subsidy represents a material part of the project costs but may be offset by increased charges for municipal and industrial use to be used to pay a portion of the Central Valley Project costs. For municipal use, interest is usually charged at a rate comparable to that paid by the Federal Government on its own long time borrowings. For some municipal uses recent rates of interest have been 2.63%. Present rates for costs allocated to municipal use under the small project loan act are 4-1/8%.

While, as previously stated, a Bureau project for importing water to this area may supply water as a unit of the Central Valley Project on a materially different basis of cost allocation and financing, the costs of such a federal project cannot be estimated at this time for comparison with the estimates that are now available for construction by the State.

COMPARISON OF ALTERNATE SOURCES OF IMPORTED WATER SUPPLY

The preceding portions of this report have discussed the water needs of North Santa Clara Valley and the sources from which imported water may be obtained. To bring out the effect of the amount of use on the cost per acre-foot, estimates have been made of the cost per acre-foot of water secured from each source for deliveries of 30,000, 60,000, and 88,000 acre-feet per year. These estimates can now be brought together for comparison. The costs for the smaller amounts of delivery are representative of the use that may occur in the initial years of operation. The use of 88,000 acre-feet per year represents the delivery capacity of the initial construction of the State's South Bay Aqueduct; it also represents the probable amount of demand for imported water for the next 20 years.

Comparison of alternate sources also needs to consider the points at which the additional water will be delivered. Deliveries to the Pressure Area will need to be by surface systems, deliveries to the Forebay can be by percolation to the ground water. Surface deliveries to the Pressure Area are limited to municipal use and their amounts are determined by the amounts of such municipal use. This requires dividing the additional supply between use in the Pressure Area and in the Forebay as the difference in the location of delivery affects materially the cost of the required works required for its delivery.

The available sources from which imported water may be secured include the following:

Water from the State's Feather River Project.

1. Via the South Bay Aqueduct
2. Via a Pacheco Pass Route

San Francisco Water Department

U. S. Bureau of Reclamation

While some additional local sources can be developed, they are small in individual size and in their total in relation to the expected demands. Present storage is adequate to regulate the main local streams. In the opinion of the Review Board any local sources which can provide additional water at a cost below that of imported water should be developed but their extent will not remove the need for securing imported water.

While the San Felipe Division of the Bureau of Reclamation Central Valley Project, now under investigation, represents an additional potential source of imported water, the results now available on its costs are insufficient to enable it to be compared with other available projects.

The discussion which has been presented previously in this report furnishes the basis on which importation of Feather River Project water by the two proposed routes can be compared. For percolation in the Forebay such a comparison can be made for the cost of delivery to the proposed West Side Conduit at Coyote Creek. For delivery to the cities in the northern area of the Valley pressure conveyance to the cities should be used.

For common service the following estimates have been derived in the preceding portions of this report.

ESTIMATED COST OF IMPORTED WATER FOR SURFACE DELIVERY FOR MUNICIPAL USE BY CITIES IN THE NORTHERN PORTION OF THE NORTH SANTA CLARA VALLEY

For Treated Water Delivered to Individual Cities	Estimated Costs Per Acre-Foot of Annual Delivery in Acre-Feet of		
	30,000	60,000	88,000
From State's South Bay Aqueduct			
1. By pipe from Airpoint across northern part of Valley	$ 78.50	$49.00	$39.15
2. By conduit from Airpoint around the Valley	107.55	64.80	50.80
From Hetch Hetchy System of San Francisco	70.00	70.00	70.00
By Pacheco Pass Route to Coyote Creek and around went side of the Valley	112.05	68.50	55.30

ESTIMATED COST OF IMPORTED WATER DELIVERED TO COYOTE CREEK FOR CONVEYANCE AND PERCOLATION IN FOREBAY

For Untreated Water Delivered to Coyote Creek at elevation 350 feet for conveyance to West Side	Estimated Costs Per Acre-Foot of Annual Delivery in Acre-Feet of		
	30,000	60,000	88,000
From State's South Bay Aqueduct	$ 63.10	$38.30	$29.80
From Pacheco Pass Route			
1. Pumping from Delta-Mendota Canal	67.50	39.25	30.00
2. Pumping from San Luis Reservoir	67.60	42.40	34.30

These estimates are all subject to the conditions applicable to each project. The capital cost for all State projects is based on 50-year serial bonds at 4 per cent inerest.

While these results include estimated costs for an annual use of water of 30,000 acre-feet per year, the best basis for comparison is for uses of 60,000 to 88,000 acre-feet which are representative of the expected use during the major portion of the bond repayment period.

For delivery to the cities in the northern portion of the Valley, the lowest estimated unit cost is that using the South Bay Aqueduct to Airpoint with a pipe line across the north part of the Valley. The factors, other than cost, affecting the comparison of service from the South Bay Aqueduct and from Hetch Hetchy have been discussed previously. Based on estimated costs and the other pertinent factors these cities should act promptly and uniformly to determine the source from which they will secure additional imported water to replace their present ground water draft and to meet their increasing needs.

For imported water to provide recharge of the Forebay, there is little difference in the estimated cost shown in the table for delivering water to Coyote Creek between the South Bay Aqueduct and the Pacheco Pass Route. As previously discussed, the factors other than cost are considered to favor the South Bay Aqueduct.

There are also some alternate choices that may be made. If all of the imported supply for the northern cities should be secured from the Hetch Hetchy System, the delivery from the South Bay Aqueduct at Airpoint would be limited to the needs for the Forebay. To deliver 30,000 acre-feet from the South Bay Aqueduct at Airpoint for these cities and an additional 30,000 acre-feet for conveyance to Coyote Creek would have a lower estimated unit cost for the water delivered at Coyote Creek than if a total supply of only 30,000 acre-feet was secured and all delivered to Coyote Creek. The results in the preceding comparisons are equivalent to the estimated costs for the delivery of the entire supply at Coyote Creek. If the northern cities are to be supplied from the South Bay Aqueduct, the extension of Aqueduct service to Coyote Creek will have lower estimated unit costs than the similar costs for service to Coyote Creek alone.

The conditions discussed above illustrate one effect that will result if imported water should be secured from a combination of sources. The lowest unit cost of service will be secured where a single system is used to meet the full demand.

WATER DEMANDS IN SAN BENITO COUNTY

San Benito is a prospective user of water from the original plan for the South Bay Aqueduct extending to its area and from any Pacheco Pass Tunnel that may be constructed. Studies have been made of its present and expected water demands and its local sources which could be developed. The reports resulting from these studies enable estimates to be made of the extent to which lands in San Benito County may represent a present and prospective future user of imported water.

Water conditions in San Benito County are not as urgent as in some other areas in the Authority. It is not threatened with sea water intrusion. While it has a present overdraft on its local ground water supplies estimated to be 7,000 acre-feet per year, past ground water lowering has not been excessive. In a report made in 1954, the U. S. Bureau of Reclamation recommended the continuation of the present use with its overdraft until the resulting ground water lowering that would occur reached the point where costs of its pumping equalled the cost of imported water.

The Review Board has examined the available reports and has found the information contained adequate for its needs in considering the requirements of San Benito County in relation to the projects now being considered. The Board has not requested additional investigations in this area.

San Benito County has not felt the recent "population explosion" that has occurred in North Santa Clara Valley. Being off of the main lines of transportation it has not had a large increase in industrial use with its resulting urbanization. While San Benito County is experiencing a healthy rate of increase, it is still primarly an agricultural area with the resulting limitations on its financial resources and its ability to meet costs for water.

The relatively smaller amount of its water demands prevents San Benito County from undertaking an importation water project for its own use alone. The resulting construction costs would be too large for the amount of water that would be used. Its area is dependent on further development of its own water resources or on its participation in a project for importing water to other areas whose demands can reduce the average costs to all users.

The San Benito County Flood Control and Water Conservation District is proceeding on a storage project to provide additional ground water recharge to areas adjacent to the San Benito River. A reconnaissance report on the Hollister Project was made in January 1954 by the Bureau in cooperation with local interests. Reports on its local project, Hernandez Reservoir, and on distribution from the outlet of the proposed Pacheco Pass Tunnel are also available. These reports contain information on water demands and estimated costs which can be used for the comparison of these different sources of water supply.

The Hernandez Project is scheduled to begin construction in 1961. The Hernandez Reservoir will be located on the San Benito River about 60 miles above Hollister. Its proposed capacity is 18000 acre-feet and its estimated mean annual yield 4,100 acre-feet. Water released from this storage will flow down San Benito River 51 miles to the existing Paicines Canal and Reservoir where it will be diverted and reregulated for releases for percolation in the channel of San Benito River below Paicines. This will enable Hernandez releases to be made at a higher rate with reduced conveyance losses above the area needing ground water recharge. The present estimated cost is $1,675,000. While bonds for the full cost have been voted, it is now planned to secure a Public Law 984 loan from the Bureau for $1,425,000 with $250,000 provided from the bonds voted by Zone 3 of the San Benito County Conservation and Flood Control District. The loan would be interest free on the portion assigned to use for irrigation and have a present interest rate of 4-1/8 per cent on the portion assigned to municipal and industrial use. It is estimated that for the first five years of operation the total use will be 95% for irrigation and 5% for municipal and industrial use. The payments will be reviewed at intervals of five years and adjusted to agree with the relative amounts of the respective uses. The estimated long-time mean use is 4,100 acre-feet per year.

In their report on the Hernandez Project, Creegan and D'Angelo estimated the cost per acre-foot on the basis of the additional cost of the project on the total present draft of the benefitted area. This additional cost was found to be $2.50 per acre-foot which would increase the present average cost of pumping from $10.50 to $13.00 per acre-foot. The repayment schedule and other costs in this report show annual total requirements varying during the repayment period from about $51,000 to $61,000 and averaging about $55,000 per year. On this basis the cost per acre-foot of the mean annual yield of 4,100 acre-feet would be about $13.50. This represents the annual cost per acre-foot of new water.

In a report dated September 22, 1959, Creegan and D'Angelo have estimated the costs of distribution to areas of service in San Benito County of water from a Pacheco Pass Route. These estimates were based on conveyance from the tunnel outlet and distribution both by gravity and by pumping. Pumping would be required for higher lands lying east and south of Hollister. The amounts of the demand in these areas were based on the needs after the Hernandez Project using storage on San Benito River had become operative. The additional present demand was estimated to be 11,000 acre-feet and the ultimate demand 52,000 acre-feet. This ultimate demand is based on the present need of 11,000 acre-feet, the present overdraft of 7,000 acre-feet reduced by 4,000 acre-feet by the Hernandez Project and the estimated additional demand for ultimate development of 38,000 acre-feet.

The estimated capital cost of this local distribution system was $3,650,000 with annual costs of $239,000 when in full use for its initial capacity of 31,400 acre-feet per year. This includes the higher level of the distribution system which would require pumping. These costs were based on 40-year repayment on four per cent interest and power costs at one per cent per kilowatt hour. For an initial construction of the gravity unit only, the estimated construction costs were $1,660,000 and the annual costs $92,000. These estimates represent an average cost of $7.60 per acre foot of annual use for the full system and $2.90 for the gravity unit only for a use from the gravity unit of 31,400 acre-feet. For the initial demand of 14,000 acre-feet these annual costs per acre-foot would be $17.00 and $6.50, respectively.

In considering the use that would be made of a source of imported water supply in San Benito County, the Board has used an initial demand of 14,000 acre-feet per year increasing to 31,400 acre-feet when the initial capacity of the proposed local distribution system is fully used. This initial capacity is less than the estimated ultimate demand of 52,000 acre-feet. The initial capacity should meet the requirement for a sufficiently long period to determine the ability of the local area to meet the costs. If these costs are met until the demand reaches 31,400 acre-feet, the then development should have no difficulty in meeting the costs for an enlargement of its local distribution system.

In estimates of the total cost of imported water to San Benito County by a Pacheco Pass Tunnel or other equivalent route the Board has used a cost for local distribution varying from $6.50 per acre-foot for an initial use of 14,000 acre-feet to $12.00 per acre-foot when the local system has been completed and 20,000 acre-feet are used (estimated to occur 15 years after the first delivery of water) and $7.60 per acre-foot when fully used (estimated to occur 25 years after the first delivery of water with a use of 31,400 acre-feet).

ESTIMATED COSTS FOR IMPORTED WATER FOR USE IN SAN BENITO COUNTY

While some plans for the importation of water to San Benito County include service to other areas, the estimated costs for water used in San Benito County can be separated to supply results applicable to this area which can be used to reach conclusions regarding the feasibility of such service.

The Policy Statement of the Department of Water Resources dated January 21, 1960, includes the following:

Pacheco Pass Tunnel Aqueduct -

Estimated Annual Capital Cost component	$980,000
Estimated O & M costs plus Delta Water Rate - per acre-foot	$14.00

This capital cost component includes interest and amortization on the construction bonds (4.65% used), depreciation, and a minimum or standby operation charge. The total component is 6.53% of the capital cost. Later estimates used by the State have been based on an annual capital cost of 4.65% only.

Applying these results to the delivery of the 37,000 acre-feet in 1985 stated in the 1959 report to the legislature, gives a capital cost component of $26.50 per acre-foot with a total charge at the tunnel outlet of $40.50 per acre-foot. The map accompanying the legislative statement shows only the Pacheco Pass Tunnel without conduits from its portal to any areas of service. The estimated deliveries in 1985 are for areas in San Benito and Santa Cruz Counties and South Santa Clara County as conveyance from this tunnel to the North Santa Clara Valley was not contemplated in these results.

The results in this Policy Statement are stated by the Department of Water Resources to have been based on the "Office Report on South Bay Aqueduct Alternate Route Studies" by H. W. Greydanus dated April 21, 1958. The estimates for delivery to San Benito County in the Greydanus report were 5,000 acre-feet in 1960 increasing to 55,000 acre-feet in 2010. The results in the Policy Statement represent the estimated delivery in 1985.

In the Greydanus report Plan I was to take water to San Benito County through the South Bay Aqueduct similar to the conduit proposed in the Feather River Project report. The total cost of this Plan was estimated to $62,800,000, the annual cost $3,730,000 and the average cost per acre-foot for all areas served about $30. The incremental costs to San Benito County areas were estimated to be $21,700,000 for construction, $1,210,000 annual costs, giving an average cost of delivery of $47 per acre-foot for a use of about 22,000 acre-feet per year. This cost included a charge of $5.00 per acre-foot for delivery at the diversion from the Feather River Canal.

Plan II was based on a South Bay Aqueduct for Santa Clara County and a Pacheco Pass Tunnel for San Benito County. The Pacheco Pass route had an estimated cost of $15,200,000 including $2,370,000 for the Feather River Aqueduct. The annual cost was estimated to be $740,000 giving a cost per acre-foot of about $30 per acre-foot for a use of about 25,000 acre-feet.

Plan III was based on serving Alameda County from a South Bay Aqueduct with San Benito and Santa Clara Counties served from a Pacheco Pass Tunnel. The estimated construction cost of this Pacheco Pass Aqueduct was $29,300,000, the annual cost $1,690,000 giving an average cost of about $22.50 per acre-foot for a total use of 75,000 acre-feet. Costs between service to San Benito and Santa Clara Counties were not allocated. Costs allocated to areas in San Benito County would result in a lower cost per acre-foot of use than for the extended system to North Santa Clara County. San Benito County might use 15,000 acre-feet in the early years of project operation; unless Santa Clara Valley used 60,000 acre-feet per year during these years the average costs to both counties would exceed $22.50 per acre-foot.

The presently available results of the State for the estimated costs of water from a Pacheco Pass Route are summarized below. These are for water diverted from the San Luis Reservoir of the Feather River Project and indicated in each case.

Greydanus Report, 1958 -

Capital cost $15,200,000 to tunnel outlet only

Annual cost $740,000 total

$30 per acre-foot for use of 25,000 acre feet.

Same tunnel project with conduit to North Santa Clara Valley -

Capital cost $29,300,000

Average cost per acre-foot for all services, $22.50

Statements of State in 1959 and 1960 -

Delivery at tunnel outlet

Project delivering 37,000 acre-feet per
year - cost per acre foot, $40.50

The preceding results are on variable standards and the costs per acre-foot are not directly comparable. The amount of water to be used varies as well as the total costs for different routes. All of the results discussed above are for delivery at the equivalent of a Pacheco Pass Tunnel outlet and do not include the additional cost for local distribution.

The 1960 Policy Statement represents the last results of the State and can be accepted as the State's present conclusion regarding the costs of delivery through a Pacheco Pass Tunnel of water from the Feather River Project. For a use of 37,000 acre-feet per year this cost is $40.50 per acre-foot. This is materially higher than the estimated costs of similar service in the Greydanus report. The Greydanus report was prepared prior to the adoption of the January 21, 1960, Policy Statement. The Greydanus report is also based on different amounts of use than the Policy Statement.

As the demand in San Benito County for imported water is not estimated to reach 37,000 acre-feet until 1985, the cost per acre-foot used in the earlier years of project operation would exceed $40 per acre-foot. Use in San Benito County is now and is expected to remain primarily agricultural. For such use the estimated cost at the tunnel outlet are in excess of $20 per acre-foot. This exceeds the cost which irrigation in this area can be expected to meet.

On the above basis securing an imported water supply for use in San Benito County appears to be dependent on the construction of some project in which the larger use and the larger share of the cost is met by some other area. This conclusion applies to all forms of project which have to meet interest charges on their costs of construction. The Bureau may develop plans for a project based on federal terms which San Benito County may be able to meet. Further consideration of a Pacheco Pass Tunnel project for use in San Benito County under available terms of local or State financing can be limited to forms of combined service with other areas.

WATER DEMANDS FOR PAJARO VALLEY IN SANTA CRUZ AND MONTEREY COUNTIES

It has been proposed that water from a Pacheco Pass tunnel should be used in Santa Cruz County. Service to the southern portion of this county could be provided by gravity conveyance from the elevation of the proposed tunnel. Santa Cruz County has become an agency in the Water Authority for the southern part of its area. The Pajaro Valley here discussed is the area along and adjacent to the Pajaro River below the narrows at Chittenden. It lies in both Santa Cruz and Monterey Counties.

Past investigations have resulted in the conclusion that the area of Santa Cruz County north of the Pajaro Valley can best secure its water supply by the development of its locally tributary streams.

The Pajaro Valley is a highly developed area surrounding and adjacent to Watsonville. It is now supplied by wells pumping from its underlying ground water. The draft from the intermediate ground water depths has exceeded the rate of transmission to the coastal area during periods of peak draft and some salt water intrusion has occurred in its intermediate ground water strata. Deepening wells from 400 to 800 feet has reached a ground water strata of good yield and quality. The use of this deeper strata is too recent to have demonstrated its extent or permanence. It may prove to be an adequate source of supply for this area, for its present and near future demands. Until the extent to which it can meet the local demands has been more fully shown by its increasing use, plans for importation of other water appear to be held in abeyance.

Bulletin 5 of the State Water Resources Board "Santa Cruz-Monterey Counties Investigation" dated August 1953 is the result of investigations in this area. While the ground water draft in 1949 was considered to be less than the total recharge, the transmissability from the Forebay was found to be less than the peak rate of draft. Storage on Corn Cob Canyon to be filled by diversion from the Pajaro River was estimated to have a cost of $20 per acre-foot of mean annual yield. The stored water would be redelivered to the Pajaro River for diversion to areas of use. A diversion canal with 200 second-feet capacity and a 21,000 acre-foot reservoir was selected as the most desirable. Such a project was estimated to have a mean annual yield of 9,700 acre-feet. The estimated cost based on 1952 prices was $3,970,000 with an annual cost of $192,000. The demand was estimated to be 4,000 acre-feet in 1949 and 10,000 acre-feet in 2000.

In a report entitled "Santa Cruz County Master Plan of Water Development" by Creegan and D'Angelo made for the Santa Cruz County Flood Control and Water Conservation District in January 1957 it was concluded that until the safe yield of the deep zone is determined, no new construction of surface water developments should be commenced for the Pajaro Unit.

There are some adjacent hill lands above the floor of the Pajaro Valley below the Gap for which a demand for water may develop. There has been some use of such lands, particularly for strawberries. Should the demand for strawberries become permanent these lands may represent a potential demand for imported water.

If a demand for additional water for present uses arises for the valley floor lands of the Pajaro Valley it will be the result of the deterioration of the present ground water supply and will probably occur as an emergency demand for immediate relief. None of the proposed projects for importing water to this area are adapted to meeting such a situation. Any Pacheco Pass Project will require several years for its authorization and construction. For higher lands adjacent to the Pajaro Valley there is no present development requiring importation of water for its present preservation.

It is concluded that eventually there may be a demand for additional water in the Pajaro Valley but that at present it does not represent a use which would construct conveyance conduits from a Pacheco Pass Project for its own use or be a prospective present participant in the cost of a Pacheco Pass Tunnel. The Pajaro Valley appears to be a more probable participant in the later stages of enlargement of the use of an original Pacheco Pass Project built to meet the present demands of other areas.

The Pajaro Valley coastal area in Santa Cruz and Monterey Counties is highly developed with the desirable valley land nearly all in use. This area will probably require surface service if salt water intrusion should occur as rates and results of ground water recharge would not be expected to be rapid enough to restore the ground water quality. This area will not undertake to replace its present ground water supply as long as it maintains a usable water quality. With the relief that is being secured by the use of deeper wells the interest of this area in an imported supply is in maintaining its position so that it will be eligible to secure such a supply if it should become available and should be needed.

Creegan and D'Angelo estimate that the ultimate requirement for supplemental water will be 24,200 acre-feet. This is about 15,000 acre-feet in excess of what may be secured from the Corn Cob Canyon Project. This estimated supplemental need is in excess of the estimated 28,000 acre-feet of present ground water recharge and assumes that the ground water draft can be controlled to enable the recharge to be used without salt water intrusion. It is probable that the cost of water from the Corn Cob Canyon Project will be less than the cost of imported water and that it will be built prior to any importation into this area. On this basis the Pajaro Valley can be considered to represent an ultimate demand for imported water of about 15,000 acre-feet. It is not considered to represent a present use which will assist in meeting the construction costs of any project for the importation of water which is now being planned for present construction.

GENERAL CONSIDERATIONS

The comparisons which have been presented have been based on relative estimated costs. In addition to costs other factors will affect the selection of the source or route to be used for imported water.

The time at which imported water can be made available is also a factor. For the service which it can supply, the Hetch Hetchy System of San Francisco is now providing service and is prepared to meet the increasing demands of its present customers. The South Bay Aqueduct is further along on its planning and initial construction than the Pacheco Pass Route. The South Bay Aqueduct also has the shorter time required for its actual construction and involves less uncertainty as it includes no tunnel comparable to a Pacheco Pass Tunnel.

The area of greatest present need is the northern part of the Pressure Area. The use of imported water here will be for municipal purposes. Water can be delivered here more quickly and at lower costs from either the Hetch Hetchy System or a South Bay Aqueduct than through a Pacheco Pass Route.

Water for percolation in the Forebay is also needed to check subsidence and dependence upon the uncertain ground water from beneath San Francisco Bay. While this need at present is not as urgent as the need for replacing present ground water draft in the northern part of the Pressure Area, water for such percolation should be secured and used as soon as practicable. Such water can also be secured more quickly from an extension of the South Bay Aqueduct from Airpoint than from a Pacheco Pass Route.

A report by a Review Board on alternate sources of supply should normally conclude with a specific recommendation of the source to be used and a program for securing delivery of water. In the present case there are some factors which are not, at this time, determinable to the extent that final decisions can be made. Among these are optional decisions which rest with separate agencies in the area. These include whatever decision may be made by the cities in the northern part of North Santa Clara Valley regarding the source of supply they will secure. If all or part of these cities elect to meet their water requirements by the purchase of Hetch Hetchy water it will affect the demand for water and the costs of its importation for other users.

Securing water for San Benito and Santa Cruz Counties from projects which have been discussed in this report is dependent on the construction of a Pacheco Pass Route for Santa Clara County. The necessary costs of the tunnel for a Pacheco Pass Route are too large to be met by the volume of the present demand in San Benito and Santa Cruz Counties only. Extension of a South Bay Aqueduct delivering water at Coyote Creek for use in San Benito and Santa Cruz Counties at this time would be expensive for the amounts of present and anticipated needs in these areas.

Based on all of the information now available and the general conditions applicable to the different sources of imported water, the Review Board has concluded that -

> An immediate decision should be made by the cities in the northern part of the North Santa Clara Valley on whether they will secure the water needed to replace their present ground water draft and their increasing use from the Hetch Hetchy system of San Francisco or from a South Bay Aqueduct.

Hetch Hetchy water is now available in adequate amount and good quality. No indebtedness on the part of these cities is needed beyond an agreement to continue to purchase Hetch Hetchy water for the life of bonds which San Francisco may issue for additional facilities, now stated to be 20 years. The present cost per acre-foot used is known and is equal to or lower than the present estimated costs of the alternate source for the earlier years of use although on longer time and larger use basis the costs from the South Bay Aqueduct as now estimated are materially lower.

Although the State has stated that it will defer extension of its South Bay Aqueduct in order to give time for these cities to reach a decision on the source from which they will secure their water supply, it is recommended that such a decision be made now and acted on so that relief from the present serious conditions may be secured as quickly as practical.

As between a South Bay Aqueduct and a Pacheco Pass Route the following general conditions are applicable:

The presently estimated costs for delivery at a common point on Coyote Creek are somewhat in favor of the South Bay Aqueduct although the differences are within the probable accuracy of the estimates.

A conduit from Airpoint to Coyote Creek will make water available for percolation into the marginal Forebay Area on the east side and enable percolation to be secured where it will be needed. For the Pacheco Pass Route the present conduit to Evergreen would need to be extended to Penitencia Creek.

There will be a greater use of water in Alameda County from a South Bay Aqueduct than in San Benito County from a Pacheco Pass Route. This will result in a reduction in the proportion of the cost of the upper works to be allocated to North Santa Clara Valley.

The South Bay Aqueduct is further along in its authorization and design, will have a shorter construction time and offers promise of earlier delivery of water than a Pacheco Pass Route.

If imported water other than the Hetch Hetchy supply should be used by the cities in northern North Santa Clara County, the South Bay Aqueduct is located where delivery to these cities can be made economically while cost from a Pacheco Pass Route would be excessive for delivery to these cities.

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There is a present need for imported water for percolation for both irrigation and for municipal use in the Forebay. Such water is obtainable only from a state or federal project delivering water to the North Santa Clara Valley or by the construction by some local agency of a conduit to the main conduits of a state or federal project. Hetch Hetchy water is not available for such service. Active efforts should be made to work out a program for such importation. One procedure would be to wait until July 1962 when the report of the Bureau of Reclamation is scheduled to be completed. The Review Board has found no project for importing water for percolation in the Forebay, at estimated costs using a four per cent interest rate, which are within the limits costs usually considered applicable to irrigation use except for partial supplemental use. Such percolated water is also subject to the cost of its pumping from the ground water in addition to the costs that have been assembled in earlier parts of this report. Importation of water for percolation in the Forebay can be accomplished at costs within the ability to pay for municipal use. A Bureau project provides interest free funds for irrigation use and charges interest for municipal use. The main reduction in cost to local use of a Bureau project would be in the interest subsidy for irrigation during the early years of the project and possible favorable cost allocations as a division in the Bureau's Central Valley Project. However, municipal use may be required to carry a portion of the irrigation cost as is now being done in the Central Valley Project. Use of water from the Forebay is rapidly changing and a project to import water there will be mainly for municipal use over the period of repayment.

A prompt decision is also needed regarding the local agency which will represent the North Santa Clara Valley in contracting for allocation and repayment of costs and for operation of the local distribution works. If South Bay Aqueduct supply is to be used by the northern cities, this agency should proceed with the necessary investigations and negotiations seeking to secure the prompt construction of a South Bay Aqueduct for delivery of water to Airpoint for treatment and conveyance to these cities. Such negotiations will include agreements with the State and with other users of the upper portions of the South Bay Aqueduct regarding joint use and allocation of costs.

A joint project of Alameda and Santa Clara Counties might build a South Bay Aqueduct on their own financing at interest rates comparable with those expected to apply to a state project or to a federal project for municipal use. Such a basis might be desirable if there should be extended delay in State construction.

Even if the South Bay Aqueduct is to be used to supply the northern cities and it is constructed promptly, it will not be available to Airpoint until the time when the report of the Bureau is now scheduled to be completed. A decision regarding the extension of the South Bay Aqueduct to supply water for percolation in the Forebay can then be made on the basis of the costs and other factors applicable to the delivery of imported water by the South Bay Aqueduct or the Pacheco Pass Routes. If the northern cities elect to use Hetch Hetchy water, the cost per acre-foot of imported water of the South Bay Aqueduct for delivery at Coyote Creek will be increased as a result of the reduced amount of use. A decision between the extension of the South Bay Aqueduct to Coyote Creek or the construction of the Pacheco Pass Route can be deferred until the terms and conditions of service obtainable from the Bureau's San Felipe Division of the Central Valley Project has become available in the Bureau's report.

For San Benito and Santa Cruz Counties the Review Board recommends that no action regarding projects for importing water for their use should be taken until the report of the Bureau of Reclamation on its investigations of the San Felipe Division of the Central Valley Project has been completed. This report is now scheduled for July 1962. Projects to be financed on a four per cent interest basis appear to result in costs for delivered water which are higher than may be feasible for agricultural use in these areas. In its 1954 report on irrigation in the Hollister area, the Bureau of Reclamation suggests that inclusion of service in San Benito County as a unit of the Central Valley Project could result in its sharing in advantages in cost distribution to its advantage. The Review Board recommends that San Benito and Santa Cruz Counties should defer commitments on a source of imported water until the report on the San Felipe project is available.

The report of the Conservation District of July 12, 1960, contains plans for four local projects. The Review Board has considered each of these projects and makes the following comments:

A Cross Valley Project will be required to distribute imported water to the areas where percolation is needed. Such a project is essential in importing water for use in the Forebay. As the runoff of Coyote Creek is now fully regulated by the existing storage it will change the location of present percolation but will not materially increase the present total use of local runoff. It should be constructed and ready for use when imported water may become available. Its construction prior to the availability of imported water would enable a better distribution of present supplies in the Forebay to be sesecured.

The Morgan Hill Project would use Anderson Reservoir storage for surface irrigation in an area north of Morgan Hill. This service would reduce by an equal amount the present percolation on lower areas in years when the supply was not adequate for both. This project represents an item of local distribution for local decision which is not within the scope of the Review Board assignment.

The Berryessa project would increase percolation in an area where present overdraft occurs. It is dependent mainly on the completion of works still in the planning stage for the treatment of the San Jose sewage to produce water suitable for such percolation. If such high quality water is provided and costs of treatment are charged to sewage disposal this project could deliver the treated water at the spreading areas at lower cost than the expected costs there for imported water. When such treated water may become available this project should be desirable. For present construction, its economy depends on the amount of runoff in lower Coyote Creek available for pumping from either natural runoff below Anderson Reservoir or from storage released from Anderson.

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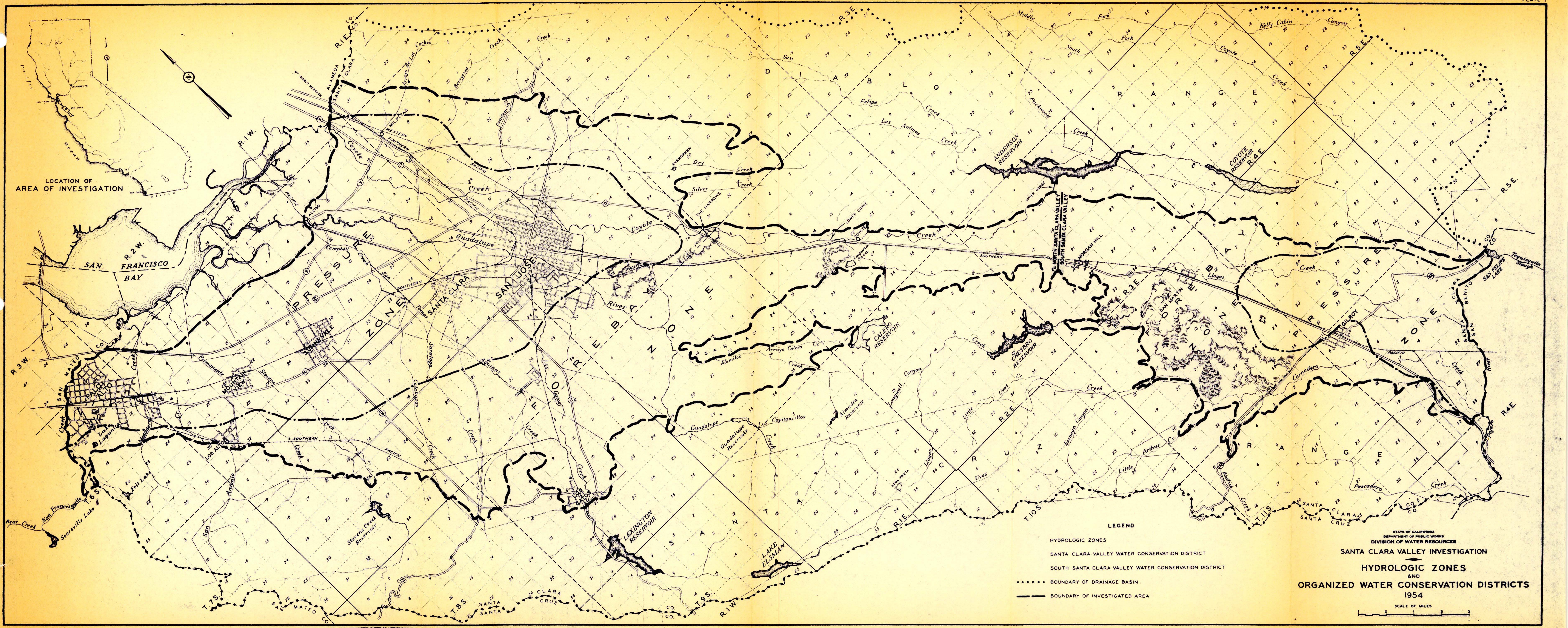

LEGEND

HYDROLOGIC ZONES

SANTA CLARA VALLEY WATER CONSERVATION DISTRICT

SOUTH SANTA CLARA VALLEY WATER CONSERVATION DISTRICT

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STATE OF CALIFORNIA
DEPARTMENT OF PUBLIC WORKS
DIVISION OF WATER RESOURCES

SANTA CLARA VALLEY INVESTIGATION

HYDROLOGIC ZONES
AND
ORGANIZED WATER CONSERVATION DISTRICTS
1954

SCALE OF MILES
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